Curriculum Support

Science 14/24

Teacher Resource Manual

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SCIENCE 14/24

TEACHER RESOURCE MANUAL

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COVER: GREEK FRET

The design on the cover is commonly called a fret. It originated in early cultures in the middle east and the far east. The fret was refined by the Greeks and used as decoration in civil architecture, pottery, and handcrafts. The fret is composed of one continuous bar which intersects at right or oblique angles and is bounded by two parallel lines.

Socrates, in his writings, spoke about the fret as a symbol of the systematic and continuous search for truth by all rational beings.

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INTRODUCTION TO THE TEACHER RESOURCE MANUAL

PURPOSE

This Teacher Resource Manual (TRM) is designed to help teachers implement the Science 14/24 program. The TRM is a support document that provides helpful information to classroom teachers. The teaching and evaluation strategies presented are suggestions only and are not mandated. The ***Program of Studies*** for Science 14/24 outlines the course which teachers are required to teach. Where portions of the ***Program of Studies*** are restated in the TRM, they are highlighted to indicate their legal status.

The Science 14/24 TRM is intended to assist teachers in translating the intentions of the Science 14/24 program into classroom practice. It provides background information on the rationale and philosophy of the program, outlining the thinking that influenced the design of the two courses. A large part of the TRM is devoted to describing teaching strategies and activities appropriate for Science 14/24. In particular, the TRM focuses on teaching the interconnections among science, technology, and society (STS). The TRM also provides suggestions for organizing, teaching, and evaluating instruction and lists print and media materials that support the program.

ORGANIZATION

The TRM is designed to accompany the Science 14/24 ***Program of Studies***. The background of Science 14/24 program is presented first and should be read carefully by everyone who will be teaching the course.

The planning section in the TRM provides useful suggestions that are intended to help the classroom teacher effectively use the time and resources available to meet the goals and objectives of the Science 14/24 program. The sections on teaching strategies and student evaluation focus on teaching and evaluation techniques that are appropriate to the STS emphasis in the program. The sample activities suggested for Science 14 and 24 follow the ***Program of Studies*** unit by unit, providing teaching activities that will help achieve the objectives stated for the unit in the ***Program of Studies***. The learning resources section lists basic and support resources that have been approved for use with students as well as additional teacher resources. The media and technology section provides addresses of the 12 resource/media centres in the province as well as the ACCESS dubbing service.

Excerpts from the Science 14/24 ***Program of Studies*** are screen in the same distinctive manner as this notice. White boxes within these screened areas indicate that information has been added for clarification.

BACKGROUND
TO THE
SCIENCE 14/24 PROGRAM

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A number of factors have influenced the development of the Science 14/24 program. The Alberta Education policy paper, ***Secondary Education in Alberta*** (1985), and the Science Council of Canada report, ***Science for Every Student*** (1984), were very influential in setting the goals and objectives of the program. The goal of scientific literacy for all students, achieved through emphasis on the interactions among science, technology and society (STS), shaped the program of studies. The cognitive development of the students was strongly considered in selecting basic and support resources and in writing suggested activities for this Teacher Resource Manual.

REVIEW OF SECONDARY EDUCATION IN ALBERTA

In 1984 Alberta Education undertook a comprehensive review of secondary education in the province. The review of secondary programs in Alberta resulted in a policy statement, ***Secondary Education in Alberta***, published in June, 1985. The policy statement set the requirements for high school graduation, and stated that a minimum of two science courses (8 credits) would be required for the General High School Diploma. The Science 14/24 program was developed to provide the science component for some students enrolled in the General High School Diploma Program. The Science 14/24 program replaces the old Science 11 course.

The Alberta secondary education review provided the opportunity for submissions from a wide range of individuals and groups within the education community and from the general public. A Ministerial Advisory Committee was appointed to review the submissions and formulate a number of recommendations for change. Regarding science, the Minister's Advisory Committee made the following observation:

The public supports the study of science as an important discipline and recognizes the impact and influence of science on our daily lives through its application in industry, agriculture, forestry, and other areas vital to Alberta's social and economic welfare.

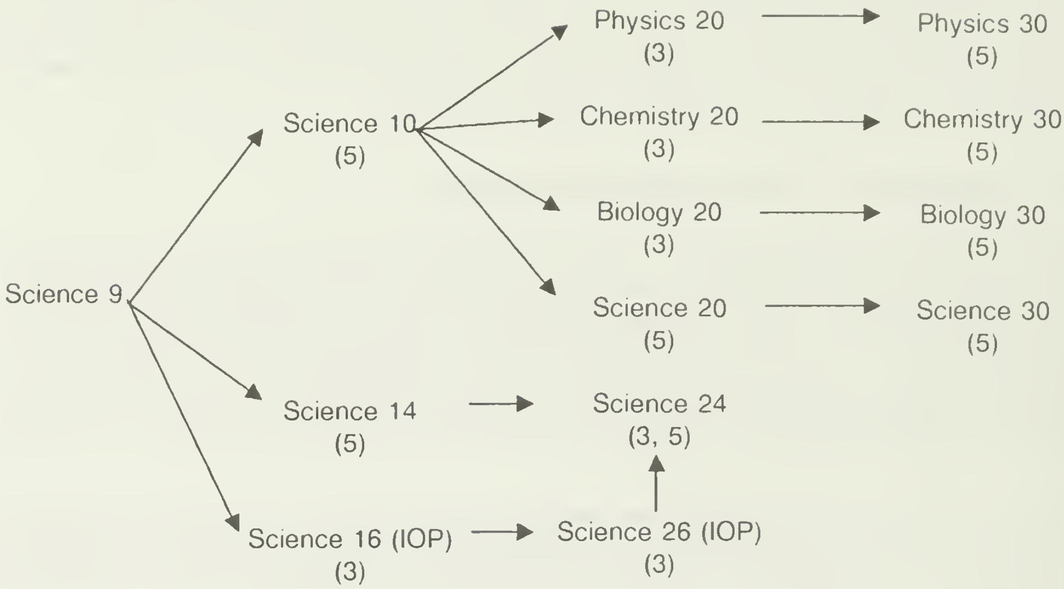
The role of science in society needs to be emphasized, with consideration given to the application of science, the social and environmental impact of scientific discoveries, and the moral and ethical issues which accompany the use of scientific knowledge.

An applied science program has merit for students entering the job market and technical and junior colleges. (***Report of the Minister's Advisory Committee: Foundation for the Future***, page 13)

The policy statement, ***Secondary Education in Alberta***, indicates that the new high school science program will emphasize basic scientific concepts and principles as well as their application in our world. As a result of this policy, Alberta's new secondary science program emphasizes the interrelationship of science, technology and society (STS). The aim of the STS approach is to provide the students of Alberta with a more balanced science education, an aim that has the support of educators across Canada and around the world.

The various course sequences in the senior high science program are illustrated in Figure 1

Figure 1. Senior High Science Courses



SCIENCE, TECHNOLOGY, SOCIETY AND CURRICULUM

In 1984, the Science Council of Canada published a report, ***Science for Every Student: Educating Canadians for Tomorrow's World***, based on a four-year study of science education in Canada. One of the central recommendations of the report was that, "science should be taught at all levels of school with an emphasis and focus on the relationship of science, technology and society (STS) in order to increase the scientific literacy of all citizens" (page 38). The Science Council's recommendations are consistent with the objectives of the international STS movement. For over a decade educators in Australia, Britain, the United States and Canada have expressed concern that current secondary science programs are too narrow and that science is being taught in a way that makes it irrelevant to students. Previous secondary school science programs tended to emphasize the theoretical aspects of the structure of the discipline while doing little to teach students how science, technology and society are related. The STS approach broadens the basis of science education by integrating into the science program accurate presentations of the nature of science, the nature of technology and their interactions with each other and with society.

To develop scientifically literate and responsible citizens, teaching must centre on students' development as thinking and caring members of society, rather than focusing on a body of knowledge isolated from its social context. It is crucial to society that scientific knowledge is used wisely, with due regard for the welfare of all members of society. The knowledge necessary for responsible action is most effectively gained by students who are convinced of its relevance. In other words, an STS emphasis in science education accomplishes three things: it helps ensure that students become both scientifically literate and socially responsible, and it motivates students to learn about science.

Technology is often the main point of contact individuals have with science. High school students are intrigued by the ever-developing gadgets and processes that characterize our age. There is therefore, a tremendous opportunity, when dealing with the relationship between science and technology, to make the subject come alive. Science deals with gravity and friction, but technology gives us the wheel. While science asks "why?" technology asks "how?" Science is aimed at increasing human understanding and ability to explain nature. Technology is aimed at developing devices or processes that have practical purposes.

Science and technology affect every aspect of the daily life of Canadians. In areas as diverse as communications, travel, agriculture and waste management, both science and technology are involved. But what is science and what is technology? Are they the same or are they different? How do science and technology affect society? How does society control science and technology? If students are to become enlightened contributing citizens in a constantly changing society they will need to know the answers to these questions. Scientific literacy is an important goal of secondary school education, as it provides a means for asking and answering some very important questions.

SCIENTIFIC LITERACY

The main goal of the Science 14/24 program is to develop scientific literacy in students. A scientifically literate person has the following characteristics:

- demonstrates a working knowledge and practical understanding of the sciences;
- has the ability to evaluate scientific evidence;
- understands the processes by which scientific knowledge is developed and can adapt those processes for personal use;
- applies science concepts, theories and processes to the investigation of everyday problems;
- understands the relationship between science and technology;
- demonstrates awareness of how science and technology can function responsibly in a social context;
- recognizes the limitations as well as the usefulness of science and technology in advancing human welfare; and
- demonstrates a continuing interest in science and technology.

The characteristics of a scientifically literate person form the basis of the four program goals for Science 14/24:

1. Acquire a Foundation of Knowledge in the Natural Sciences
2. Comprehend the Nature of Science
3. Understand the Relationship Between Technology and Science
4. Understand the Role of Science and Technology in Societal Issues

CONCEPTS, SKILLS AND ATTITUDES

The concepts, skills and attitudes acquired by students in the Science 14/24 program will provide a basis for students well into the 21st century where they will be spending most of their lives. These students are the citizens of tomorrow; they need knowledge of the world around them in order to make informed choices within their own lives and communities, and for the future.

In a document titled, ***Essential Concepts, Skills and Attitudes for Grade 12***, developed by Alberta Education in May 1987, concepts, skills and attitudes were organized within 10 categories: self–concept and lifestyles, interpersonal relations, critical and creative thinking, communication, science and mathematics, lifelong learning, citizenship, career exploration, consumer and producer awareness, and global and environmental awareness. The concepts, skills and attitudes illustrated in the Science 14/24 units collectively address this and attempt, through activities related to each unit, to assist students in achieving them.

The cognitive levels of thinking skills, based on Bloom's taxonomy, have been specified in the content statements for each unit. Each concept is subdivided into behavioural objectives, while skills and attitudes are stated directly in behavioural terms. These specific statements allow the teacher to identify the type of instruction and outcomes required for each concept and skill.

Bloom's taxonomy can be used to determine the cognitive level necessary for students to perform a particular task—knowing, comprehending, applying, analysing, synthesizing or evaluating.

Bloom's Categories	Thinking Skills	Cognitive Levels
Knowledge (K):	knowledge of specific facts, terminology concepts, procedures, techniques, theories laws or conceptual schemes.	Concrete
Comprehension (C):	identify, translate, describe, select, process interpret, estimate, extrapolate or present information in the form of a functional relationship.	Concrete
Application (Ap):	application of knowledge and methods of science to unfamiliar problems.	High concrete or low formal
Analysis (An):	analyse, recognize, interpret, evaluate and relate various problems, statements, theories laws, situations or models.	High concrete or low formal
Synthesis (S):	deduce, derive, formulate, design, revise, refine, extend, generalize, select, or produce operations, communications, experiments, models and relationships.	Formal
Evaluation (E):	justify, debate, solve, recommend, judge, criticize, prove, dispute, measure, choose, validate, select, rate.	Formal

When Bloom's category is specified and the cognitive level of the student is considered, appropriate teaching strategies can be designed. As previously mentioned, most Science 14/24 students will be operating at the Concrete Operational level, with a small percentage exhibiting Formal Operational thinking. Thus it is imperative that teachers attempting instruction of concepts and skills at the higher level of Bloom's categories (levels of cognition higher than the majority of students are functioning at) use teaching strategies that involve heavy conceptualization. These higher concepts and skills must be firmly based in the student's own experience and must be very concrete. Extension from this base must also be as concrete and personally relevant as possible.

CURRICULUM EMPHASES

In the Science 14/24 program the concept of ***curriculum emphases*** is used to systematically introduce knowledge of the interrelationships among science, technology and society. A curriculum emphasis is a coherent set of messages about science which can be communicated both implicitly and explicitly (Roberts, 1982). The concept of curriculum emphases takes into account both the ***content*** and the ***intent*** of science education. Content refers to the scientific concepts and principles studied in a unit, while intent refers to the purpose or reason for studying the content. Thus, a curriculum emphasis in science education is a coherent message about why students are to study a particular set of scientific concepts and principles. To curriculum developers and classroom teachers alike, the coherence and flow of curriculum emphases (intent) are as much matters of concern as the coherence and flow of the subject matter (content) itself.

The goals of the secondary school science program prescribed by the ***Program of Studies*** are mandatory objectives for science teaching and learning in Alberta schools. The goals statements make provisions for preparing students for their role as citizens. These directives also address the needs of potential scientists and technologists. Each of the goal statements focuses on a particular aspect of these intentions. For example, one intention is that students understand basic scientific concepts and principles. Another is that students understand the way technology works. A third is to develop students' understanding of the way society deals with issues that have a scientific or technological component. Together these goals communicate to teachers the intent of policy to address a ***range of reasons*** for studying school science.

When Roberts (1982) developed the concept of curriculum emphases, he indicated that not all objectives can be met to the same extent in all units of study. For example, if the nature of science, or the interdependence of science and technology, or decision making on STS issues are to be introduced into the curriculum, then each of these objectives can be emphasized in different units of study in a program. For example, in Science 14 the "Body Systems" and "Household Science" units have a nature of science emphasis because they lend themselves to designing experiments and collecting and interpreting data. The "Investigating the Environment" unit lends itself to an emphasis on STS issues and the "Understanding the Technology" unit lends itself to an emphasis on the relationship between science and technology. By matching each topic of study to a particular curriculum emphasis the objectives dealing with the nature of science or STS issues can be covered more systematically and extensively than is otherwise possible. By selecting an appropriate emphasis for each unit, the Science 14/24 program provides a balanced treatment of the general learner expectations stated for the program.

PROGRAM CONTINUITY

It will be helpful for science teachers at all grade levels to be aware of the continuity between the junior and senior high school science programs. Both the junior and senior high school science programs emphasize the interactions of science, technology and society (STS). The differences between the two programs have to do with developmental needs and abilities in students at the two levels. Where the junior high approach is one of developing operational understandings, the senior high program tends to be more analytical and goes much farther in developing abstract understandings of the nature of science, the nature of technology, and the interactions among science, technology and society. The units of study and their primary emphases are outlined below for the two programs.

JUNIOR HIGH SCIENCE PROGRAM

Grade Seven Science

1.	Characteristics of Living Things	(NS)
2.	Structures and Design	(ST)
3.	Force and Motion	(NS)
4.	Temperature and Heat Measurement	(NS)
5.	Micro–organisms and Food Supplies	(STS)
6.	Evidence of Erosion	(NS)

Grade Eight Science

1.	Solutions and Substances	(NS)
2.	Energy and Machines	(ST)
3.	Consumer Product Testing	(STS)
4.	The Earth's Crust	(NS)
5.	Growing Plants	(ST)
6.	Interactions and Environments	(NS)

Grade Nine Science

1.	Diversity of Living Things	(NS)
2.	Fluids and Pressure	(ST)
3.	Heat Energy: Transfer and Conservation	(ST)
4.	Electromagnetic Systems	(ST)
5.	Chemical Properties and Changes	(NS)
6.	Environmental Quality	(STS)

SCIENCE 14/24 PROGRAM

Science 14

1.	Body Systems	(NS)
2.	Household Science	(NS)
3.	Investigating the Environment	(STS)
4.	Understanding Technology	(ST)

Science 24

1.	Disease Defence	(ST)
2.	Energy Consumption	(NS)
3.	Materials We Use	(ST)
4.	Safe Transportation	(STS)

Suggested Science 14/24 Optional Units

1.	Nutrition	(STS)
2.	Geology	(NS)
3.	Weather	(NS)

KEY

Primary Emphasis:

NS = Nature of Science
ST = Science and Technology
STS = Science, Technology and Society

In addition to continuing the STS themes introduced in Junior High Science, the Science 14/24 Program builds on the solid foundation of science developed in junior high, as illustrated below.

	Junior High Science	Science 14
Grade 7	Characteristics of Living Things	Body Systems
Grade 7 Grade 8 Grade 9	Temperature and Heat Measurement Solutions and Substances Chemical Properties and Changes	Household Science
Grade 8 Grade 9	Interactions and Environments Environmental Quality	Investigating the Environment
Grade 7 Grade 9	Structure and Design Electromagnetic Systems	Understanding Technology

	Junior High Science	Science 24
Grade 7	Micro–organisms and Food Supplies	Disease Defence
Grade 7 Grade 8 Grade 9	Structures and Design Force and Motion Heat Energy: Transfer & Conservation	Energy Consumption
Grade 7	Structures and Design	Materials We Use
Grade 7 Grade 8	Structures and Design Consumer Product Testing	Safe Transportation

GENERAL LEARNER EXPECTATIONS FOR SCIENCE 14/24

1. Foundation of Knowledge in the Natural Sciences

The student will demonstrate an understanding of:

1.1 ideas fundamental to science
- 1.1.1 matter has structure and composition and there is an interaction among its components
- 1.1.2 matter and energy are conserved in reaction systems
- 1.1.3 living organisms are interdependent with one another and their environment
- 1.1.4 life forms exhibit uniqueness, diversity and a changing nature
- 1.1.5 physical laws and theories attempt to explain the universe
- 1.1.6 chemical and physical systems are in a state of dynamic equilibrium

1.2 the application of knowledge as part of systematic interpretation of natural phenomena.

2. Nature of Science

The student will demonstrate an understanding of:

2.1 science as a disciplined way to develop explanations for natural phenomena
- 2.1.1 empirical evidence plays an important role in the development of scientific knowledge
- 2.1.2 scientific explanations are developed through interpretations and conceptual inventions which are theoretical in nature
- 2.1.3 proposed theories may be supported or refuted by experimental evidence

2.2 scientific knowledge as cumulative and subject to change.

3. Science and Technology

The student will demonstrate an understanding of:

3.1 the interaction between science and technology
- 3.1.1 technology is a process of solving practical problems
- 3.1.2 technological development includes both products and processes
- 3.1.3 technology is a rapidly evolving area in modern society, requiring ongoing study
- 3.1.4 the functioning of products and processes may be explained using scientific knowledge
- 3.1.5 science can be used to advance technology and technology can be used to advance science

3.2 the limitations of scientific knowledge and technology.

4. Science, Technology, Society

The student will demonstrate an understanding of:

4.1 how science and technology influence and are influenced by societal issues
- 4.1.1 many of the effects of science and technology on society are unforeseen
- 4.1.2 societal factors such as economic, political, ethical, and moral forces interact with science and technology exerting significant influence
- 4.1.3 technological products and processes develop in response to societal needs and wants
- 4.1.4 compromises are often needed to arrive at workable situations involving science and technology in society
- 4.1.5 various societal decisions can be evaluated in terms of related scientific and technological thinking

4.2 the societal, technological and scientific aspects of an issue through use of appropriate research and communication.

GENERAL LEARNER EXPECTATIONS FOR SCIENCE 14/24

ATTITUDES

1. Scientific Attitudes

Students will be encouraged to develop the affective attributes of scientists at work including

1.1 curiosity
1.2 respect for evidence
1.3 inclination to tolerate uncertainty
1.4 intellectual honesty
1.5 open-mindedness
1.6 critical-mindedness
1.7 perseverance
1.8 creativity and inventiveness
1.9 appreciation for group work
1.10 suspended judgment
1.11 objectivity
1.12 confidence in personal ability; and
1.13 respect for accuracy and precision.

2. Attitudes Toward Science

Students will be encouraged to develop the feelings, opinions, beliefs and appreciations which individuals have formed as a result of interacting with the various aspects of the scientific enterprise, including

2.1 a positive attitude toward mathematical and scientific process skills
2.2 an appreciation for the utility of computational competence and problem-solving skills
2.3 an appreciation that, in solving problems scientifically, new technologies develop
2.4 an appreciation of the roles that science and technology play in serving human needs
2.5 an appreciation of the need for problem solving and informed decision-making at both personal and societal levels
2.6 an appreciation of the contributions science and mathematics have made to our cultural heritage and civilization
2.7 an appreciation of the contributions and limitations of scientific and technological knowledge to societal decision-making
2.8 an appreciation that ethical dilemmas may arise from the application of scientific research and/or technological developments
2.9 a sensitivity to the living and non-living environment; and
2.10 an appreciation of the roles of science and mathematics in explaining the complexity of the natural world.

SKILLS

1. Initiating Skills

Students will be expected to demonstrate an ability to distinguish between relevant and irrelevant information early in the cognitive process by

1.1 defining problems
1.2 identifying issues

1.3 setting goals by establishing direction and purpose
1.4 formulating questions to guide research/inquiry
1.5 identifying variables and assumptions.

2. **Information-Gathering and Data-Collecting Skills**

Students will be expected to demonstrate an ability to consciously consider the substance or content to be used in the cognitive process by

2.1 using an experimental design or research plan to gather data/information
2.2 obtaining qualitative and quantitative data
2.3 accessing relevant information
2.4 assembling and effectively using apparatus and equipment
2.5 recording data.

3. **Organizing Skills**

Students will be expected to demonstrate an ability to arrange or structure information so it can be understood or presented more readily by

3.1 classifying
3.2 comparing/contrasting
3.3 ordering and identifying patterns and trends
3.4 drawing graphs, charts, flow charts, maps, and diagrams
3.5 expressing data in the form of a mathematical relationship.

4. **Analyzing Skills**

Students will be expected to demonstrate an ability to classify existing information by examining parts and relationships, and to identify and distinguish components, attributes, claims, assumptions, or reasons by

4.1 interpreting data or information
4.2 judging the reliability or validity of the data or information
4.3 identifying errors
4.4 distinguishing between facts and values; relevant and irrelevant information
4.5 identifying main ideas
4.6 identifying attributes and components
4.7 identifying relationships and patterns
4.8 identifying perspectives; and
4.9 detecting bias and inconsistencies in a line of reasoning.

5. **Generating Skills**

Students will be expected to demonstrate an ability to make connections among new ideas and prior knowledge, and to add information beyond what is given by

5.1 predicting
5.2 hypothesizing
5.3 explaining and elaborating
5.4 inferring and generalizing from the data or information
5.5 designing experiments or devising a plan for research
5.6 identifying and developing alternatives; and
5.7 identifying further problems, questions, and issues to be investigated.

6. **Integrating Skills**

Students will be expected to demonstrate an ability to combine new information and prior knowledge by

6.1 summarizing and communicating findings
6.2 developing consensus within a group
6.3 making a decision; developing a conclusion/solution
6.4 incorporating new information into existing theories or knowledge
6.5 changing existing knowledge structures to incorporate new information.

7. **Evaluating Skills**

Students will be expected to demonstrate an ability to assess the logic and quality of ideas and information by

7.1 considering consequences
7.2 establishing criteria to judge reliability and validity of the data or information
7.3 assessing a design or the approach taken to solving problems and decision-making
7.4 assessing the achievement of the goals set and action taken.

CONCEPTS

1. **Foundation of Knowledge in the Natural Sciences**

Students will be expected to demonstrate an understanding of ideas fundamental to science, including

1.1 matter has structure and composition and there is an interaction among its components
1.2 matter and energy are conserved in reaction systems
1.3 living organisms are interdependent with one another and with their environment
1.4 life forms exhibit uniquity, diversity, and a changing nature
1.5 physical laws and theories attempt to explain the universe
1.6 chemical and physical systems are in a state of dynamic equilibrium; and
1.7 the application of knowledge is part of a systematic interpretation of natural phenomena.

2. **Nature of Science**

Students will be expected to demonstrate an understanding of science as a disciplined way to develop explanations for natural phenomena, including

2.1 empirical evidence plays an important role in the development of scientific knowledge
2.2 scientific explanations are developed through interpretations and conceptual inventions which are theoretical in nature
2.3 proposed theories may be supported or refuted by experimental evidence
2.4 scientific knowledge is cumulative and subject to change.

3. Science and Technology

Students will be expected to demonstrate an understanding of the interaction between science and technology; including

3.1 technology is a process of solving practical problems
3.2 technological development includes both products and processes
3.3 technology is a rapidly evolving area in modern society requiring ongoing study
3.4 the functioning of products and processes may be explained using scientific knowledge
3.5 science can be used to advance technology and technology can be used to advance science; and
3.6 scientific knowledge and technology have limitations.

4. Science, Technology, and Society

Students will be expected to demonstrate an understanding of how science and technology influence, and are in turn influenced by, societal issues, including

4.1 many of the effects of science and technology on society are unforeseen
4.2 societal factors, such as economic, political, ethical, and moral forces, interact with science and technology, exerting significant influence on each
4.3 technological products and processes develop in response to societal needs and wants
4.4 compromises are often needed to arrive at workable situations involving science and technology in society
4.5 various societal decisions can be evaluated in terms of related scientific and technological thinking; and
4.6 the scientific, technological, and societal aspects of an issue can be identified through appropriate research and communication.

PLANNING

GENERAL PLANNING INFORMATION

NATURE AND NEEDS OF THE LEARNER

The Science 14/24 program was designed for students who have experienced difficulty in junior high science. Such students may have a negative attitude toward science, perceiving it as difficult, useless, or irrelevant. Lack of confidence, low self-esteem or apathy may be present to varying degrees. Motivation becomes the key to success with these students. A high activity/problem-solving orientation, focusing on science as it applies to their everyday lives, can serve to rekindle interest. Active participation can lead to concept and skill development, and this in turn to growth of confidence and self-esteem. Attitude development is difficult to assess but development of a more positive attitude toward science as well as a more scientific attitude can be encouraged in this program. The attitudes to be encouraged are listed in the "General and Specific Learner Expectations" sections of the ***Program of Studies***.

COGNITIVE DEVELOPMENT

How students think, feel and grow affects how they learn best. When we have a clear understanding of our students' cognitive, social and physical development, we are able to use these insights when choosing activities and teaching methods. Our informed choices can then be aimed at meeting and, indeed, extending student development through the appropriate stages.

During the last 20 years there has been a considerable amount of research done on the Piagetian framework for cognitive development and its implications for teaching science and mathematics. Research tells us that the majority of students in Science 14/24 will be operating at the concrete operational level, with only a small percentage exhibiting formal operational thinking.

Concrete operational thinking is characterized by its dependence on personal or tangible experience. At this level, students think logically about things and events, but usually in the context of their immediate experience, therefore having little access to abstracting principles from the past or future. They are able to coordinate two aspects of a problem at the same time, and can mentally reverse actions or operations, as for example when they build classification systems and then break them down into subgroups. However, they may have difficulty in projecting a trend or hypothesizing, abilities which develop with formal operational reasoning.

Formal operational thinking, then, can be characterized as the development of hypothetical (i.e., if–then) thinking. Students are able to handle multiple sources of information, and, unlike concrete operational thinkers, have their underlying abilities rooted more in formal logic than in spatial perceptions. A more thorough discussion of human cognitive development is given in the Alberta Education document ***Students' Thinking: Developmental Framework, Cognitive Domain*** (1987).

Classroom application of the Piagetian framework means that the students respond well to concrete, physical objects or experiences that show what the concept "looks like." Questioning techniques that are sensitive to their cognitive level, yet also challenge them to extend their thinking, are encouraged. Introducing subjects by first finding out what the students already know is developmentally appropriate.

CURRICULUM EMPHASES

The primary curriculum emphasis or intent of each unit is either Nature of Science, Science and Technology or Science, Technology and Society. The Foundation of Science Knowledge goal is met by the science content within each unit. The principles and theories of science are taught within the framework of the curriculum emphases. Although each unit has a primary emphasis the remaining two will be present to a lesser degree and should be interwoven within the unit where appropriate.

The curriculum emphases provide the intent of study for a particular unit and indeed the course as a whole. They provide the student with an **explicit** framework for learning and an answer to the question "Why are we doing this course or unit?"

The "Teaching Strategies" chapter suggests ways to integrate explicit teaching of the science content within particular curricular emphases (page 49–61).

TEACHING THINKING

Often, thinking procedures and ways to organize information have been embedded in the presentation of content, with the assumption that students will develop these thinking skills as they learn the content of a course of studies; direct instruction in thinking skills was not seen as necessary. Teachers themselves have not always been aware of the range of thinking skills they were using and modelling for their students.

An educated individual of the 21st century will be characterized not so much by the possession of a particular body of knowledge as by the ability to bring thinking skills to bear on ever–changing bodies of knowledge. Thus the emphasis in education is shifting from acquiring the content of a subject to learning the processes by which we may continue to understand and organize growing and changing bodies of information.

Thinking skills can no longer be assumed to develop automatically as a by–product of education. The best possible education depends upon the basic premise that thinking can and indeed should be taught as an **explicit** component of curricula.

The skills section of the General Learner Expectations prescribe a seven–category framework of thinking skills felt appropriate to teach within the context of science. The listing may not be all inclusive but is a base to work from. This seven–category list may be collapsed into a simpler, broad problem–solving model (see p. 23)

Even more important than the particular approach used to teach thinking is the explicitness of thinking skill instruction. Students should be made aware that what they are learning is just one of many ways to think. As teaching thinking becomes an explicit requirement across the curriculum and integration with the content of the subject occurs, metacognition – the student's awareness that she or he is using a specific thinking strategy model – provides the basis for understanding the possibilities and limits of particular thinking skills. The more students reflect upon how they are thinking, the better they will become at discovering new and appropriate ways to approach both old problems and new.

The "Teaching Strategies" chapter suggests ways to teach for thinking (pages 68 – 74).

Recommended Reading for Teaching Thinking

Thinking Skills: An Alberta Education Discussion Statement, Alberta Education, Curriculum Support Branch, May 1989.
Teaching Thinking: Enhancing Learning, Alberta Education, Curriculum Support Branch, September 1989

LANGUAGE ACROSS THE CURRICULUM

Language can be defined as the sum total of talking, listening, reading and writing. It should not be thought of only as communication. Language has another dimension, "language for learning." Language is closely intertwined with the thinking process as students engage in activities such as putting new ideas into words, testing their thinking on other people or fitting new ideas with old. Such activities are required to bring about new understanding.

Communication can be seen as telling someone else something you already know or understand. Clearly language is essential in this activity.

Language should be developed for both purposes: communication and learning. An integration of the **explicit** teaching of communication skills with the teaching of the science curriculum, is the objective.

In science courses the development of effective reading, written, oral and viewing skills are just as important as in language arts or social studies. Appropriate strategies for such skill development should be modeled in science courses in the content of science activities, and a certain component of evaluation should be allocated to communication skills.

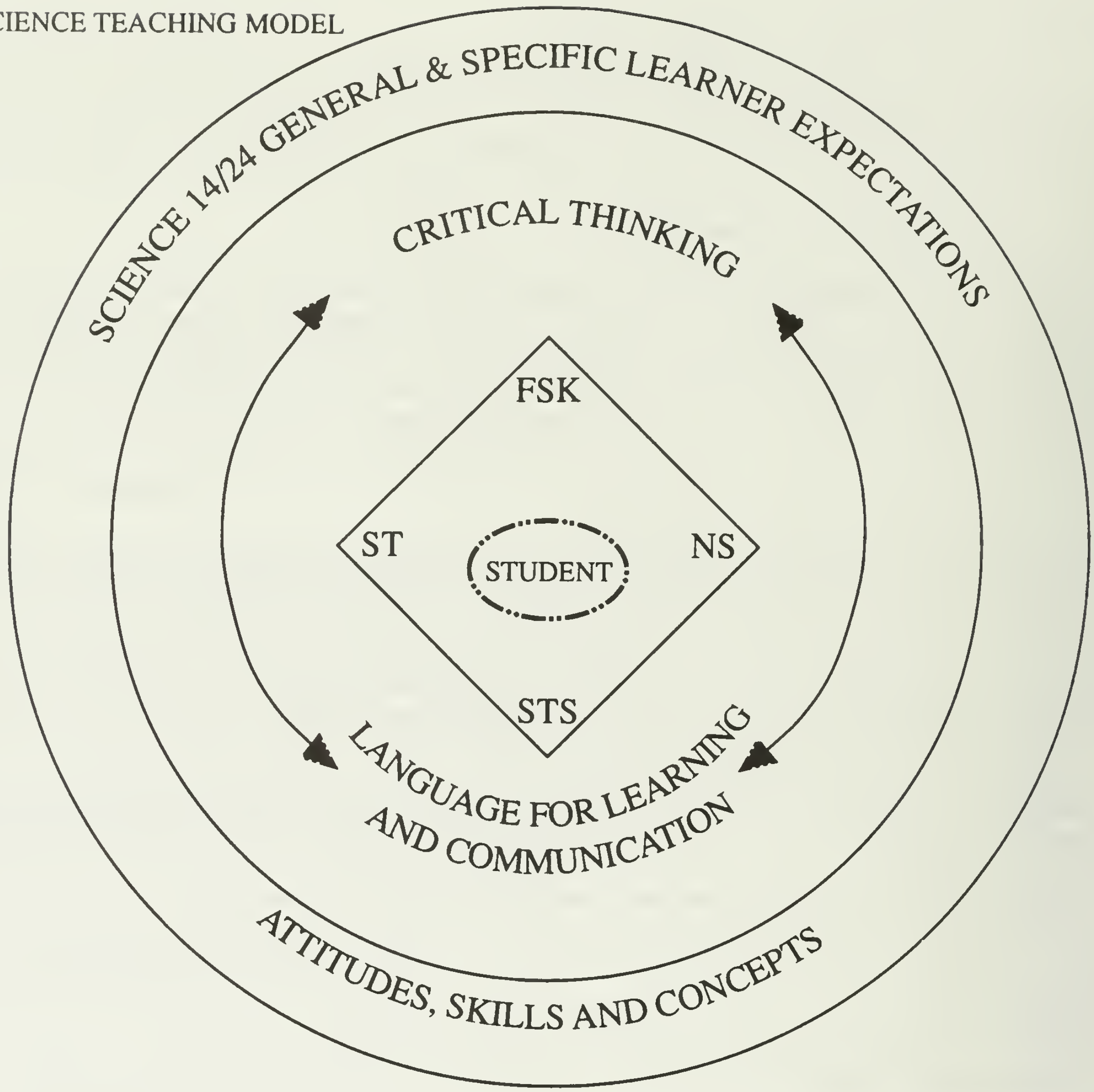
The communication skill development models presented in science should be consistent with those presented in language arts. Evaluation criteria should be similar. In the "Teaching Strategies" chapter, models for reading, writing, oral and viewing skill development are presented, while in "Student Evaluation" chapter, evaluation criteria for such skills are suggested.

The "Teaching Strategies" chapter suggests ways to teach language for thinking and communication (pages 76 – 90).

Recommended Reading

Roots in the Sawdust: Writing to Learn Across the Disciplines, National Council of Teachers of English
Language Across the Curriculum: Guidelines for Schools, National Association for the Teaching of English in Association with Ward Lock Educational

SCIENCE TEACHING MODEL



KEY

··—	Activity Orientation
◇	Curricular Emphases
FSK	Foundations of Knowledge in the Natural Sciences
NS	Nature of Science
ST	Science Technology
STS	Science, Technology, Society

The above model is meant to summarize how the goals of the Science 14/24 curriculum, the General and Specific Learner Expectations, are to be accomplished in the classroom setting. It indicates the importance of explicit teaching of thinking and language coupled with the teaching of science within selected combinations of the four curriculum emphases, or intents.

PROBLEM-SOLVING ORIENTATION

In this document, problem solving is used in a very broad sense. Problem solving can be represented by a nonlinear, four-category model. This model includes:

Planning: noting patterns and discrepant events in an attempt to seek information, organize precise questions, generate hypotheses or theories, and design experimental procedures.

Collecting Data: selecting variables and instruments in order to observe, measure, quantify, identify significance, estimate and create models.

Analysing Data: predicting, inferring, graphing, tabulating, correlating, and classifying of information.

Explaining: describing, defining, synthesizing, interpreting and communicating information to create or refine models, predictions, hypotheses and theories.

This model can be adapted and applied to virtually any activity in this course. Science inquiry, decision making, library research and assignments require specific applications of the general problem-solving model. Possible strategies can be modeled by the teacher, fellow students or the individual student. The ultimate goal is that students develop the ability to select and/or design and successfully apply appropriate problem-solving strategies in a wide variety of situations, both within the Science 14/24 program and in their everyday lives.

Active involvement of the student in a variety of problem-solving activities is essential. The teacher becomes a facilitator, encouraging critical thinking and problem-solving strategies, which in turn encourages the development of the desired attitudes, skills and concepts. Ideally, teachers become more than conveyors of science knowledge, redirecting their time and energy toward the encouragement and support of students who are actively involved in developing appropriate thinking skills within a science context. Such an orientation demands a great deal of interaction in the classroom, both between the teacher and the students and among the students themselves.

Two specific problem-solving models used in the Junior High Science courses are given below. Teachers and students can use these models as guidelines for problem-solving activities. It is not intended that students would be evaluated on the steps within the model.

SCIENCE INQUIRY MODEL

QUESTIONING
- Recognizing Patterns and Discrepant Events
- Identifying and Asking Relevant Questions

PROPOSING IDEAS
- Hypothesizing
- Predicting

DESIGNING EXPERIMENTS
- Identifying and Controlling Variables
- Developing Procedures

GATHERING EVIDENCE
- Observing
- Measuring

PROCESSING EVIDENCE
- Organizing and Presenting Data
- Identifying Patterns and Trends

INTERPRETING EVIDENCE
- Inferring
- Developing Theoretical Explanations and Models

SOCIETY/DECISION INQUIRY MODEL

IDENTIFYING ISSUE

IDENTIFYING ALTERNATIVES

RESEARCHING
- Examining Background Information
- Examining Perspectives on Each Alternative
- Identifying Consequences of Each Alternative

REFLECTING AND DECIDING
- Considering Consequences
- Considering Perspectives

TAKING ACTION
- Demonstrating Responsibility Through Personal Action
- Demonstrating Responsibility in
- Actions as a Member of a Group

EVALUATING
- Evaluating Effects of Actions
- Evaluating Decision-Making Process

CLASS SIZE AND SAFETY

Depending on the nature of the activity, students work individually, in pairs, or in larger groups. To facilitate the success of this high activity orientation, as well as assure the safety of the students involved, administrators are asked to give close consideration to maintaining appropriate class sizes.

Safety becomes a major consideration when students are very active in a laboratory setting. A "Safety in the Science Classroom" reference list can be found on page 296.

EQUIPMENT AND MATERIALS

The high activity orientation of the Science 14/24 program requires pre-planning and the gathering of materials required for each lesson. Assuming a standard, well-equipped science laboratory, the materials required are for the most part simple, inexpensive and easily obtained. A petty cash system set up at the school facilitates purchase of and reimbursement for required items. Students can develop valuable skills and increased confidence when actively involved in the planning, gathering of materials and clean-up necessary for the activities.

EVALUATION

Student evaluation techniques are an important consideration in course planning. Specific suggestions, explanations and formats are presented in the "Student Evaluation" section of this document. General guidelines that affect planning are addressed here.

Encouraging a positive attitude toward science is a large part of the General Learner Expectations for this program. A teacher can assess the student's general attitude toward science by administering a simple pre- and post-course attitude inventory. The results will indicate if shifts in attitude toward science have occurred. Attitude assessments at the end of each unit, if properly designed, can be extremely useful in deciding what revisions might be necessary to make a particular unit more effective. Attitudes are not meant to be evaluated for grades. An initial assessment of the level of students' skill and understanding in relation to each unit of study is recommended. This can be done in a variety of creative ways, ranging from informal questioning and observation to more formal pre-tests. Such an assessment allows the teacher to tailor the course to the needs of the students, both individually and collectively. The information gained is useful in deciding how to use the elective component of the course; for remediation, extension or for introduction of additional content.

Evaluation of problem-solving ability and thinking skills is often difficult with pen and paper types of testing. Several different types of evaluation, including student self-assessment are discussed in the "Student Evaluation" section.

Evaluation criteria should be drawn up before the course begins. A plan for mark distribution over the whole course as well as for each unit should be prepared and distributed to students. Evaluation guidelines for individual activities should be established and made explicit to students before the activity begins. Evaluation guidelines should be simple, clear and concise.

Ideally, students' progress should be evaluated to some degree in every class period. A variety of techniques, with particular emphasis on observation and questioning, student self-assessment and holistic scoring are suggested. Such continuous evaluation creates an ongoing awareness in both student and teacher of the level of attitude, skill and concept development. It can encourage attendance and participation and serves to motivate students through constant reinforcement.

SPECIFIC PLANNING

The Science 14-24 program has a required and an elective component, defined as follows:

- The required component provides the Specific Learner Expectations within the required units of study and comprises 80% of the program.

- The elective component provides opportunities to adapt and enhance instruction to meet the diverse needs, abilities, and interests of individual students. This component of the course may consist of remediation and enrichment, or one of the optional units outlined below and comprises 20% of the program.

The elective component can be used for:

> enrichment of the required component of the program to provide challenges and depth; remediation of the required component to provide additional assistance and reinforcement; or additional learnings to provide alternative instructional activities consistent with the learner expectations of the required component.

For Science 14 course (five credits), all four required units must be completed.

For Science 24 (five credits), all four required units must be completed. If Science 24 is offered for three credits, any two of the four required units must be completed.

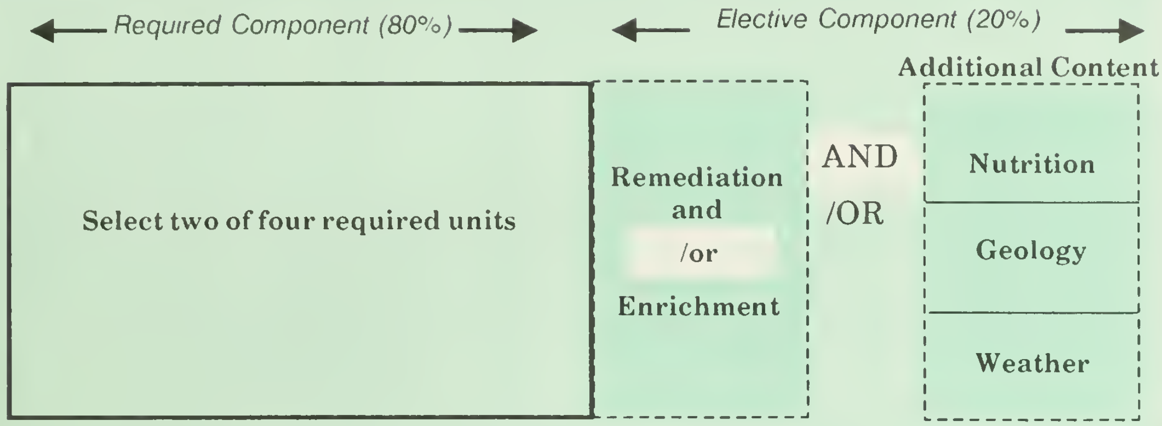
Science 14 (5 credits)

← *Required Component (80%)* →		*Elective Component 20%*		*Additional Content 20%*
Unit 1	Body Systems	Remediation and /or Enrichment	AND /OR	Nutrition
Unit 2	Household Science			Geology
Unit 3	Investigating the Environment			Weather
Unit 4	Understanding Technology			

Science 24 (5 credits)

← *Required Component (80%)* →		← *Elective Component (20%)* →		Additional Content
Unit 1	Disease Defence	Remediation and /or Enrichment	AND /OR	Nutrition
Unit 2	Energy Consumption			Geology
Unit 3	Materials We Use			Weather
Unit 4	Safe Transportation			

Science 24 (3 credits)



Elective time should be spent in a manner best suited to the nature and needs of the learner.

Three optional units are provided. Optional units serve as possible elective component material, either as enrichment or additional content. A teacher may select one or more of these suggested optional units to serve as elective for either the Science 14 or Science 24 courses. These optional units are not intended to be prescriptive but to serve as models. Optional units may be developed or selected locally, subject to the following provisions being met.

1. All optional program content must support the General Learner Expectations of the program.

2. Inclusion of optional content must not detract from the achievement of the Specific Learner Expectations of the required component of the program.

Any optional unit taught becomes part of the 20% elective component of the program.

TIME PER UNIT

In Science 14 or Science 24 (offered for 5 credits) all four required units must be covered. Each required unit should be allotted approximately the same amount of time. A 5–credit course is 125 hours of instruction. An allotment of 25 hours per required unit with the remaining 25 hours spent on the elective component, be it remediation, extension of a required unit or additional content, is suggested. If Science 24 is offered for 3 credits (62.5 hours), any two of the four required units may be selected for study. Each of the two selected units should take approximately 25 hours. The elective component would be approximately 12.5 hours.

UNIT SEQUENCE

Unit sequence for these courses is not prescribed. They may be taught in any order the teacher feels appropriate. For example, in Science 14, a teacher may choose to do Unit III, Investigating the Environment, as the first unit of the course, taking advantage of the milder weather for field trips. The remaining three units can then be taught in any order deemed appropriate. The elective component can be integrated within required units as remediation or extension or additional new material, in the form of an optional unit, may be introduced at any appropriate point in the course.

SEQUENCE OF SPECIFIC LEARNER EXPECTATIONS

Within each unit the order of the Specific Learner Expectations is not meant to be prescriptive. It is expected that by the time the teacher completes the unit all the attitudes, skills and concepts will have been addressed but in no particular prescribed order.

TOTAL COURSE PLAN

Using a calendar or sheet indicating dates and days, draft a plan to indicate which units will be covered, in which order, and on which days. Block off school days that will be lost due to statutory holidays or other predetermined events you are aware of within your school. This allows for equitable distribution of the time available and will lead into the specific planning for each unit which involves establishing dates for field trips, guest speakers, library research, AV ordering and viewing, equipment ordering and unit quizzes.

MONTHLY GENERAL PLANNING OR RECORD SHEET

A simple monthly master sheet has been included in the following section for use in recording class activities or in general monthly planning (page 35).

UNIT PLAN

A specific plan for an individual unit can be drawn up in a variety of ways. One possible format is shown on the following pages. This sample unit plan addresses the first five periods of the Science 14 course. In this case, given that unit sequence is not prescribed, the teacher has chosen Unit IV, Understanding Technology, as the introductory unit of study. All activities and evaluation techniques mentioned are dealt with in the teaching strategies or evaluation sections of this document. This format is useful as a period-by-period survey, facilitating planning and organization for each individual class. Masters are provided for this unit plan format (pages 31 and 33).

DAILY LESSON PLAN

A suggested format and six sample lesson plans are provided on pages 42–48. These six one-hour lessons are the introductory lessons for the Science 14 course assuming Unit IV, Understanding Technology is the first unit taught. They are detailed plans for the unit outline given on pages 29–30.

LIBRARY LIAISON

The Science 14/24 program now includes three explicit primary curricular emphases; nature of science, science and technology and science, technology and society. As a result, the program lends itself to the use of the library for various research projects. It is recommended that school librarians be made aware of the new program of studies and the need for resources to support it. Single copies of teacher reference books suggested in the TRM can be ordered. Science and/or technology periodicals can also be ordered or if already stocked, multiple copies might be considered. Resources at an appropriate reading level for these students should be made available. A list of suggested resources and useful periodicals will be provided in a future mailing. Detailed information is provided in the Library Research Strategy Section (pages 91 – 109.)

Recommended Reading

Focus on Research, Alberta Education, September 1989

PRELIMINARY UNIT PLANNING

Science 14
Unit IV: Understanding Technology

Emphasis: Science and Technology
Total Time: 25–30 hr   25–30 periods

*Outline designed to meet Specific Learner Expectations, pages 197 & 198

Period	General Activity Description	Evaluation Technique	Student Work	Required Resources (references, handouts, materials) *italics – teacher resource*
1.	• ST collage activity – establish guidelines and evaluation criteria for both collage production and oral presentation	Holistic Scoring (focused), p. 43	collages handed in (work in pairs)	Program of Studies/TRM Collage Guidelines & Evaluation Criteria Glue sticks, old magazines Large sheets of paper Dictionaries
2.	• Student pairs present and post collages – both group members speak • Introduction to ST emphases	Holistic scoring (all-or-none), p. 128		Oral Presentation Guidelines and Evaluation Criteria
	• FDS, NS, ST, STS emphases presented explicitly with concrete example; i.e., styrofoam cup routine – p. 43	Holistic scoring (all-or-none) p. 128	notebooks – emphases summarized in their own words using an example to illustrate	Program of Studies/TRM "Emphases" assignment guidelines
	• Present guidelines and evaluation criteria for "Technology" scrapbook project p. 45–49	Holistic scoring (analytic), p. 55	scrapbook project handout pages in order, filed in notebook–project section	Scrapbook Project guidelines and evaluation criteria
	• Cover SQ3R method – work through sample withclassp. 70–71	Holistic scoring (all-or-none,) p. 128	SQ3R example completed	Sample article (copyright cleared) SQ3R strategy handout – pp. 76–77
3.	• Video – supporting ST emphasis	Self–Assessment–personal performance inventory, p.127	questions done in notebooks/participate in discussion/file guidelines	• Video focus questions for discussion and assignment, pp. 89–90 • Viewing guidelines and evaluation criteria
	• Establish behavioural expectations – set tone • Course overview and specific Unit Plan • Present evaluation plan • Discussion & questions regarding the above	Holistic Scoring (all-or-none) – done at the beginning of next period	notebooks – all handouts included in order – return signed general statement to parents and students	• Prepared Course Plan showing units and emphases • Evaluation Matrix, p. 119 • General Statement to Students and Parents, p. 120

PRELIMINARY UNIT PLANNING (continued)

Period	General Activity Description	Evaluation Technique	Student Work	Required Resources (references, handouts, materials) *italics – teacher resource*
4.	• Attitude to Science Survey (pretest)	Diagnostic Assessment–Results on Summary Sheet, pp. 135–147	complete survey	Survey forms/*Instructions for administering and scoring, Survey Synopsis,* p. 135–141
	• Resource Module Intro – format, classroom organization for activities established	All–or–none scoring	point form summary of textbook strategies (webbing, outline, flowchart, etc.)	Guidelines for efficient use of a textbook – discuss and share strategies, p. 78 Model strategies for summarizing,
5.	• Do Unit 2, – Science, Technology and Your Five Senses from basic resource Module Science, Technology and You.	Self–Assessment (P.P.I., p. 127) Holistic Scoring (focused) Observing and Questioning students in rotation – background for comment card or checklist, pp. 122–125	complete unit 2 and do assignmed questions in notebook – hand in	Science, Technology and You – ISIS module, Unit 2
6.	• Do Unit 4, – The Scientific Process and Electricity from basic resource Module Science, Technology and You.	Observing and Questioning students in rotation – background for comment card or checklist, pp. 122–125 All-or-none scoring	complete all activities and do assigned questions in notebook	Science, Technology and You – ISIS module, Unit 4
	• Video – Acme School of Stuff – Electricity	All–or–none scoring in class	• discussion • focus questions done in notebook	Video and teacher support package Focus questions for video

* Continue to develop using Resource Module, TRM, Library, Video, Field Trips, Speakers, Projects . . .

One possible route: Electricity→Sound→Telephone→Amplifiers→Sound System comparison (TRM)
This route follows the basic resource module fairly closely through to the telephone and then uses the TRM as a guide.

* Alternative Routes—Electricity/Sound/Light/Simple machines/Electric Motors
All the above possibilities are supported by the Activity Section of the TRM.

PRELIMINARY UNIT PLANNING

Science ____________________
Unit ______________ ______________________________ Emphasis: ______________________________
Total Time: ________________ hr ____________ periods

Period	General Activity Description	Evaluation Technique	Student Work	Required Resources (references, handouts, materials)

PRELIMINARY UNIT PLANNING (continued)

Period	General Activity Description	Evaluation Technique	Student Work	Required Resources (references, handouts, materials)

MONTH: ____________ YEAR: ____________ CLASS: ____________

SUN	MON	TUE	WED	THU	FRI	SAT

NOTES: ____________

TEACHING STRATEGIES

The teaching strategies described in this section are suggested as ways to effectively integrate the following framework of the General and Specific Learner Expectations into the Science 14/24 program.

- **Explicit** curricular emphases
  - Foundations of Science Knowledge
  - Nature of Science
  - Science and Technology
  - Science, Technology and Society

- **Explicit** teaching of thinking skills

- **Explicit** teaching of language skills

Using this framework for the teaching of science may sound like a formidable task. However, science teachers have always used this framework to a greater or lesser degree. Any curriculum taught has an intent, or curriculum emphasis, although it may not have been explicit. Teachers model certain patterns of thinking for students and encourage students to think in a variety of ways. Communication skills are essential to any course of studies. The difference comes in the intent to make curricular emphases, thinking strategies and communication strategies explicit to the student. When these aims are explicit to the student, student learning is focused. Being explicit with students implies they will be provided with answers to the following questions:

What are we doing?
Why are we doing it?
How can I accomplish it?
How can I evaluate it?

Assuming the student is a partner to all three intents of the course and that the course content is presented in a fashion congruent with these intents, learning can be optimized. There is then no "hidden curriculum," no assumption that thinking and communication skills will develop automatically as course content is covered.

Science 14/24 students will benefit greatly from clear guidelines and model strategies for the development of thinking and communication skills. When students are aware of the curriculum emphases, they understand the reasons for studying science, and are therefore more motivated. During the presentation of the General and Specific Learner Expectations a teacher can provide a framework and guidelines to encourage thinking and communication skills as an integral part of each activity. Such guidelines, coupled with teacher and student modelling, appropriate questioning techniques, supportive classroom atmosphere and organization, and a variety of appropriate evaluation techniques will result in better learning of the science curriculum.

RANGE OF ACTIVITIES

Curriculum emphases, thinking and communication can all be addressed within a single activity, if that activity is carefully planned.

Information supporting the teaching of thinking and communication skills within science course activities are found on pages 68 – 90.

General activities that support all three intents are listed below. Specific activity suggestions for each unit of study are found in the "Sample Activities" section.

General Activities Supporting Curriculum Emphases, Thinking and Communication

Scientific Investigations

- have students develop and talk through a method of scientific investigation (tap previous knowledge)
- present a model of science inquiry (page 24)
- design an experiment
- evaluate a product
- group cooperation activities in science inquiry/idea sharing (page 61 – 67)
- student self–assessment (page 126 – 127)
- teacher observation and questioning (page 122 – 125)

History of the Development of Science Knowledge and/or Technology

- follow historical scientific investigations, both successes and failures
- use great thinkers in science/inventors as models
- research projects for written or oral presentations (pages 91 – 109)
- trace development of scientific knowledge and technology focusing on the interaction between the two, using a specific example; e.g., microscope, nuclear research, lasers, ultrasound

Science, Technology, Society Connections

- have students talk through their approaches to resolving issues; discuss the variety of methods
- model a decision–making strategy (page 24 and 65–66)
- work through an example and have students practice components of the model
- oral or written reports, surveys, on pros and cons
- identify the science and technology perspectives on an issue
- identify social perspectives on an issue
- carry out research projects on an STS issue
- discuss or debate an STS issue

Promotion of Thinking and Communication Skills

- metacognition – activities that encourage thinking about thinking, expressing thought patterns
- brain–storming (pages 62 – 63)
- focused discussion
- reading for learning strategies (SQ3R, PQ4R) (pages 76 – 77)
- note–taking strategies (webbing, limiting space)
- oral presentation guidelines (page 157)
- debating/researching pros and cons (pages 87 – 88)
- research strategies (pages 91 – 104)
- viewing and listening strategies
- mnemonics
- study strategies (pages 111 – 113)
- test–taking strategies (pages 111 – 113)

Use of Newspapers and Periodicals

- distinguishing fact from opinion
- identification of perspectives on science related issues – beginning with scientific and technological perspectives (pages 58 – 60)
- consideration of validity of sources and detection of bias
- incorporation into bulletin board and scrapbook activities (pages 56 – 61)
- using SQ3R method to increase reading and thinking skills within a science context (pages 76 – 77)
- using as background in preparation of written and oral assignments
- collage activities (pages 42 – 43)

Community Liaison

- contact agencies within the community to provide field trip possibilities, guest speakers, films, print material
- students can survey community members for opinions on controversial issues like seat belt legislation, or to ascertain habits as related to such areas as energy use of recycling
- organize awareness raising activities, encouraging participation; e.g., blood drives, inviting Alberta Transportation to present the "Convincer" to the community, recycling initiatives
- use the community for examples and as subject of research wherever possible; e.g., ecology field trip, as base for data of investigations – focus on local technology and issues whenever possible

Government Agency Awareness

- students can contact municipal, provincial and federal government agencies for information on any science–related issue
- students can be involved in writing letters, phoning, or visiting these agencies to request information or express an opinion on an issue
- compile a list of government agencies/representatives students would contact regarding pertinent science–related issues (see list of government agencies providing teacher support materials, (page 278)

Library Liaison

- cooperative ventures in research with the librarian, language arts, and/or social studies teacher
- research activities on a large variety of science, technology and society topics (pages 103 – 109)
- model research strategy, reinforce and build on skills already acquired (pages 91 – 102)

Creative Projects on Science, Technology and Society Themes

- produce videos
- write poems, songs
- design magazine covers, posters, collages
- design an original technology
- create a model to illustrate a science principle or how a particular technology works
- develop general or self–evaluation criteria for any activity

PUTTING IT INTO PRACTICE

SAMPLE DAILY LESSON PLANS — SCIENCE 14

The following six–lesson sequence was developed to demonstrate the integration of the explicit teaching of curricular emphases, thinking skills and communication skills within the Science 14 course. High student activity with explicit guidelines and evaluation criteria are stressed.

This six–lesson sequence provides detailed lesson plans enlarging on the more general outline provided in the Specific Planning section (page 29 & 30). The plan assumes these are the first six lessons of the Science 14 course and that the teacher has chosen to begin the course with Unit IV, Understanding Technology. The period length assumed is one hour.

* These lessons are designed to meet selected Specific Learner Expectations (pages 182 – 183).

Unit IV Understanding Technology

Science–Technology Emphasis

LESSON ONE

Topic: What is science?
What is technology?

Aims: Immediate involvement of students in a purposeful activity (collage)
Assessment of students' initial understanding of science and technology
Begin to establish the following expectations:
- activity focus
- participation and accountability every period
- explicit assignment and evaluation criteria provided
- cooperative group work
- oral presentation
- teacher mingles with students while they work, observing and questioning

Materials: Old magazines, scissors, poster paper, glue sticks, dictionaries

Procedure:

1. Provide guidelines for collage activity:

Collage Instructions
– work in pairs – one sheet of poster paper per group – fold or mark sheet in half – illustrate with pictures, "science" on one side and "technology" on the other – define, in your own words, "science" and "technology" on the back of collage – look up dictionary meaning for "science" and "technology" and write beside your own meanings – plan your oral presentation for next period – each member to participate, one explaining the collage and one presenting the groups' definition for science and technology – clean up your area and hand in collage before end of period

2. Provide explicit evaluation criteria for collage activity (Focused Holistic – adapted from "Product" column of Evaluation Matrix, page 129):

Collage Evaluation Plan	
5	Collage complete S/T definitions included, both personal and dictionary Commands respect, neatly done
4	Mostly complete Correct, neat Good work
3	Somewhat complete Satisfactory effort Tidy
2	Incomplete Major Faults Untidy Unsatisfactory effort
0	Not done or handed in
E	Acceptably excused from assignment

3. Provide explicit guidelines for oral presentations, page 157 and discuss as goal for future assignments.
4. Explain "all–or–none" evaluation of oral presentation, preparing for next period (2 marks for doing it, 0 if not done).
5. While students work on collages, circulate, observe, encourage, question, get acquainted.
6. Alert students 10 minutes before end of period; remind to plan oral presentation and to clean up, returning supplies to designated areas.
7. Collect collages for grading at end of period.

LESSON TWO

Topic: What is science? What is technology? What is society?

Aims:
- hear students' perceptions of science and technology during oral presentations
- familiarize students with the types of questions associated with science, technology and society: What? Why? Should? format, using concrete examples
- introduce the major project for the first unit – a scrapbook on technology
- introduce and work through example of article analysis using SQ3R method, developing a useful strategy for the scrapbook project

Materials:
- "Dealing with Different Types of Problems" sheets and props for particular example you wish to work through (pages 49 & 50)
- SQ3R Guidelines and sample article (pages 57 – 58)
- scrapbook project guidelines and evaluation criteria (pages 51 – 55)
- copyright information for Alberta newspapers (pages 56 – 57)

Procedure:

1. Have student pairs present their collages and definitions orally: all–or–none scoring.
2. Present (with a student role playing if possible) "Dealing with Different Types of Problems": use any of the suggested examples or your own to establish idea of: Why? How? Should?, as related to science, technology and society.
3. Briefly introduce the intents of the units in this course as FKS, NS, ST, STS; relate these back to question types associated with each intent.
4. Assign for homework a brief summary of the four intents of the units as related to the types of questions they deal with; include a concrete example, preferably an original set of questions, evaluate using all–or–none scoring at beginning of next period while students view video dealing with cassette tapes.
5. Present guidelines and evaluation criteria for this unit's major project – a scrapbook on "Technology in the News."
6. Pass out SQ3R method sheets and work through model article with students, having them actually do steps on the sample; check for completion (all–or–none scoring.)

LESSON THREE

Topic: What is involved in the production of audio cassettes? (science-technology connections)
What are the behavioural expectations in this class?
What are the evaluation schemes for the course and this unit?

Aims:
- use a video to establish the science-technology relationships for a technology popular with teens, the cassette tape
- introduce self-assessment of performance
- establish behavioural expectations
- communicate course and unit evaluation criteria to students and parents

Materials:
- ***Acme School of Stuff*** video series – Cassette tape clip and associated background sheet (pages 89 – 90)
- Effective Viewing guidelines (page 84) (adapt listening process to viewing process)
- Personal Performance Inventory (page 127)
- Course Overview: show emphasis (page 10)
- Unit Overview: use evaluation criteria to demonstrate unit activities (page 119)
- Evaluation Criteria: general statement to students and parents (page 120)

Procedure:

1. Distribute background to video sheets: set assignment of questions to focus viewing, allowing time to read them over and clarify them if necessary.
2. Distribute Personal Performance Inventory to be completed and handed in by the end of the period; discuss value of such an instrument.
3. View video and allow 10 minutes to work on questions.
4. Distribute behavioural expectations: a few simple, clear rules felt appropriate for optimal class learning.
5. Distribute block diagram of course units and go over emphasis rotation and integration from unit to unit.
6. Distribute General Statement to students and parents and go over the evaluation plan presented; allow time for discussion and questions; explain that the parents must read and sign the statement and student must return it next period.
7. All handouts to be filed in notebook at the front with the signed notice to be included next period; all–or–none scoring at the beginning of the next period.

Allow 5 minutes at end of period for Personal Performance Inventory; collect, return next period; students file in self-assessment section of notebook.

LESSON FOUR

Topic: What is your attitude toward science?
How will the resource modules be used in this course?

Aims:
- determine the class attitude toward science using an attitude inventory
- determine students' strategies for using print resources
- introduce the resource module and explain how it will be used in the classroom
- provide a survey of the resource features and offer suggestions for efficient use
- have students summarize the above points

Materials:
- attitude survey forms for students, administration and scoring information for teacher (pages 135 - 143)
- resource module for each student "Science, Technology and You," ISIS series, Globe Modern Curriculum Press, 1988 by Glen Hutton
- guidelines for efficient use of the resource module (adapted from page 78)
- guidelines for standard class procedure indicating how the resource fits into the plan, see below.

Procedure:

1. Have another person administer attitude inventory after explaining the inventory to the students.
2. Distribute resource modules and ask students to page through them, identifying the features of the modules and describing how they might be used; e.g., caution symbol in left hand margin containing safety information, questions to be answered are in red, data tables and graphs are not to be written on, bolded words are defined in glossary at end of module, materials required for investigations are bracketed.
   - brainstorm ideas for summarizing
   - model a few strategies like webbing, point form, flow chart, or paraphrasing
   - have students summarize points of efficient use of text using method of their choice
   - establish standard period procedure through discussion and handout

Standard Classroom Procedure

- teacher presents background and assignment for the day in first 5 minutes
- the activity number, title and questions to be completed will be listed on the board
- notes to be copied will also be on the board
- students listen to instructions, copy any notes given and proceed to complete activity and assigned questions during the period
- students ask for clarification of any instructions not understood
- students are responsible for return of equipment and clean-up
- students will complete any self-assessment required before end of class
- should student finish early enrichment activities should be attempted and handed in for bonus marks

- allow last 10 minutes of period for completion of summaries and for students to skim the first chapter of the resource module
- collect summaries, all-or-none scoring, return next period or mark as many as possible as students complete them in class.

LESSON FIVE

Topic: What is science? What is technology? What is a fact? a theory? a law?

Aims:
- practice standard classroom procedure using the first resource chapter as the base
- reinforce previous definitions of science and technology with resource activities and questions
- students do a second self-assessment of their performance during the period
- students become more comfortable with teacher observation and questioning while they are working on the activity
- consider if students are paired in a manner conducive to learning (regrouping may be necessary)

Materials:
- list of the selected questions to be assigned from module
- personal performance inventory sheets (page 127)
- record material from teacher observation; comment cards or sheet for each student (pages 122 – 125)

Procedure:

1. In first 5 minutes explain assignment, listing chapter and questions to be completed on board (questions.... teacher selects).
2. Distribute personal performance inventory and have students read it over again as a focus. Do not fill it out until after the activity is complete; have students fill out inventory in last 5 minutes.
3. Students work in pairs through the activity, cooperate to answer questions and individually record answers in their notebooks.
4. Students hand in questions and personal performance inventory at end of period.
5. For students who finish early, enrichment material such as magazines, crosswords, article with questions or brain teasers should be available.

LESSON SIX

Topic: What is the process of scientific inquiry? What is electricity?

Aims:
- determine the students' conceptions of scientific inquiry
- develop a model of scientific inquiry
- have students work through the activity demonstrating the steps of the model
- use a resource activity to develop a concept of electricity
- use a short video clip to further develop the concept of electricity

Materials:
- prepared sheets with scientific inquiry model (page 24)
- resource module Science, Technology and You, Unit 4
- list of selected questions to be assigned from Unit 4 of module
- per group of students:
  - two pith balls suspended on threads
  - rubber rod
  - glass rod
  - piece of wool
  - two laboratory stands with rings
- video background and focus questions for ***Acme School of Stuff*** series, "Electricity" video clip (10 minutes)
- Video
- video machine

Procedure:

1. Pose questions to students: What is electricity? How do you know? Write their perceptions of the board and record any evidence they present to support their ideas.
2. Ask students what method they might suggest using to determine the true nature of electricity?
3. When experimenting, observing, studying, researching and such suggestions come up ask what they recall about the Scientific Method or Science Inquiry. Brainstorm to collect all ideas on board and try to develop a "model."
4. Pass out one model of science inquiry and discuss its application to the investigation in Unit 4. Students file the model in their notebooks.
5. The assigned questions should be written on board and students directed to work through Unit 4, completing the activity 15 minutes before the end of the period. All–or–none scoring of notebooks while video is presented.
6. Introduce video and pass out focus sheets, assigning the four questions to be done in notebook for next period (all–or–none scoring at beginning of next period.)
7. Students should be prepared to discuss the video and questions at the beginning of the next period.

DEALING WITH DIFFERENT TYPES OF PROBLEMS

← STS →

← ST →

← FKS & NS →

	SCIENCE	TECHNOLOGY	SOCIETY
PROBLEM	Why does my coffee cool so quickly?	How can I make a container to keep my coffee hot?	Should we use styrofoam cups or ceramic cups for a meeting?
RESPONSE	Heat energy is transferred by conduction, convection, and radiation.	A styrofoam cup will keep liquids hot for a period of time.	Personal health, the environment, cost & availability must be considered along with science and technology information.
PROBLEMS ARISE FROM	curiosity about events and phenomena in the natural world.	coping with everyday life, practices, and human needs.	different views or perspectives based on different or the same information.
TYPES OF QUESTIONS	What do we know? How do we know?	How can we do it? Will it work?	What alternatives or consequences are there? Which choice is best at this time?
PROBLEM-SOLVING STRATEGY	Scientific Inquiry	Technological Problem Solving	Deliberation Consensus Building
SOLUTION RESULTS IN	knowledge about the events and phenomena in the natural world.	an effective and efficient way to accomplish a task.	a defensible decision in the particular circumstances.
PROBLEM TYPE	Theoretical	Practical	Issues
	WHY?	HOW?	SHOULD?

Key to Emphases

FKS	–	Foundations of Knowledge in the Natural Sciences
NS	–	Nature of Science
ST	–	Science and Technology
STS	–	Science, Technology and Society

DEALING WITH DIFFERENT TYPES OF PROBLEMS

Possible Alternative Sample Questions

← STS →

← ST →

← FKS & NS →

SCIENCE	TECHNOLOGY	SOCIETY
Why do leaves turn colour and drop in the fall?	How can they be collected and disposed of?	Should leaves be disposed of by burning?
Why does my cola go flat when it sits?	How could I prevent this?	Should soft drink companies be allowed to sell beverages in non–returnable containers?
Why does bread go mouldy?	How can we prevent bread from moulding?	Should preservatives be added to bread?
Why do car engines require oil?	How can motor oil be produced?	Should motor oil be recylced?
What is sound?	How can sound be "trapped" on records, cassettes or CD discs?	Should government agencies legislate and enforce certain sound level limits?
What is an acid or an alkali?	How can acidity or alkalinity be measured?	Should strong acid or alkali substances be transported by truck on public highways?
What makes cakes rise?	How are cake mixes kept dry?	Should cake mixes have both internal and external packaging?
WHY?	**HOW?**	**SHOULD?**

Key to Emphases

FKS – Foundations of Knowledge in the Natural Sciences
NS – Nature of Science
ST – Science and Technology
STS – Science, Technology and Society

SCRAPBOOKS

Scrapbooks can be an effective way of getting students to collect and organize newspaper and magazine articles on a particular STS issue, e.g., hazardous waste disposal, quality of local drinking water.

In order to get a range of viewpoints on an issue, students should compile their articles from current newspapers and magazines over a three – to four–week period. The organization of the articles may be left open so that the students may group them according to criteria of their own choosing, such as topic, theme, viewpoint, or date. There should, however, be some recognizable order to their grouping.

For each article, students should indicate its source and date, and underline the main ideas. It would be appropriate to mention that often in these types of articles, main ideas are stated in the first four or five paragraphs and that the remainder of the article provides supporting details. Students could also summarize each article in a few sentences, so that the teacher can see if the students have grasped the main ideas contained in the article. Students could also try to identify the perspective that the author of the article is taking on the issue; that is, are the points discussed mainly dealing with **scientific** research, **technological** solutions, **economic** matters, **environmental** concerns, or **political** alternatives.

It is very helpful for students if the teacher models part of the assignment by collecting articles, and grouping and displaying them on a wall or bulletin board.

Evaluation of the scrapbook can be accomplished by using a holistic marking key. Students should be made aware of the components and expectations of the evaluation strategy at the start of the activity.

A detailed sample scrapbook project outline follows on pages 52–55.

EVALUATION OF SCRAPBOOK

Name_______________________ **Comments:**

Identification of main ideas	1	3	5	x	2 =	/10
Analysis and classification of articles	1	3	5	x	2 =	/10
Generalizations	1	3	5	x	2 =	/10
Presentation, neatness, sources	1	3	5	x	2 =	/10

SAMPLE SCRAPBOOK PROJECT

Science 14: Unit IV – Understanding Technology

This would be the major project for this unit, contributing 10% of the students' unit mark. It should be introduced early in the unit (second or third period) to allow ample time for completion. It is designed to take approximately four weeks to complete.

"Technology in the News" ← Scrapbook Project

Aim:
- realize the importance of science and technology in our modern society through reading newspaper articles
- develop skills in reading newspaper articles for the purpose of identifying the main ideas and specific viewpoints within them (SQ3R or other reading strategy)
- develop a functional classification system for articles
- plan and organize well, completing each phase of the assignment on time

Materials Required:

- newspapers – daily for two–week period
- scrapbook (25 pages ample)
- scissors, glue, highlighters (preferably light colour)

Instructions:

- Clip from newspapers at least one article on technology each day for two weeks beginning ________, and ending ________.
- 25 articles in total will be the minimum required, at least one per day.
- write date and source on each article when you clip it.
- On ________, (one week after initial assignment) bring the articles you have clipped and your scrapbook to class and discussion of the classification of articles into appropriate categories will occur. *
- Develop a system that works for you. An initial evaluation will occur based on your completion of the assignment to date – articles and scrapbook brought to class and the classification system you develop.
- Continue clipping articles and begin gluing them into appropriate sections of the scrapbook. Leave space beside each article for possible summary later on. You may find it necessary to add a few more sections to your scrapbook as you go along. By ________, you should have collected at least 25 articles and have them glued into the scrapbook in appropriate sections. Bring to class ________ (two weeks into project) for evaluation of progress.
- On ________ (end of two weeks) begin identifying articles which have a particular viewpoint strongly expressed. Look for one article for each viewpoint listed below.
- Label the article indicating the viewpoint to be highlighted.

*A teacher should have in mind possible sample sections, e.g., communications, transportation, computer, medical and dental, biotechnology, sound.

- Highlight those parts of the article which express that particular viewpoint.

  Viewpoints:
  - technological
  - scientific
  - societal
    - economic
    - political
    - environmental
    - legal
    - ethical

- See the bulletin board for examples of articles expressing each viewpoint and how they should be presented.
- Seven articles will be identified and highlighted, one for each viewpoint. This should be completed and brought to class for ________ (three weeks after assignment). An evaluation of progress to that point will be done – seven articles with viewpoints identified and highlighted are required.
- During the fourth week, ________ to ________, the scrapbook assignment will be completed by selecting three articles and summarizing their main ideas using any summary techniques you feel works well; e.g., webbing, flow chart, paraphrasing, point form. These summaries should be placed next to the article in the scrapbook. The scrapbook will be handed in ________ for final evaluation.

TIMELINE FOR
"TECHNOLOGY IN THE NEWS" SCRAPBOOK ASSIGNMENT

Target Dates	Tasks Completed
Evaluation 1 (*class period date*)	Week One – articles clipped, at least one per day – scrapbook obtained – articles and scrapbook brought to class – sections of scrapbook determined in class
Evaluation 2 (*class period date*)	Week Two – all 25 + articles clipped and glued into appropriate sections and scrapbook brought to class
Evaluation 3 (*class period date*)	Week Three – seven articles identified as to strong viewpoint expressed with parts of articles highlighted – one article for each viewpoint – bring scrapbook to class
Evaluation 4 (*class period date*)	Week Four – three articles selected and main ideas summarized in the form you selected – complete – bring scrapbook to class and hand in for final evaluate

"TECHNOLOGY IN THE NEWS"

SCRAPBOOK EVALUATION SCALES

Name:________________________
Class:________________________

1. Satisfactory Completion (on date specified)

	Complete Well Done	Almost Complete Satisfactory	Incomplete Poor Effort	Not Done or Did not bring in
Week 1	5	3	1	0
Week 2	5	3	1	0
Week 3	5	3	1	0
Week 4	5	3		0

TOTAL =

2. General Impression

Commands Respect very neat, well ordered, excellent effort	Generally Pleasing acceptably neat, minor faults, well done	Not Pleasing messy lacks organization, poor effort	Not done
10	7	3	0

3. Article Viewpoint I.D. (7 total)

6–7 viewpoints accurately identified 6–7 article parts accurately highlighted	4–5 viewpoints accurately identified 4–5 article parts accurately identified	1, 2, or 3 viewpoints accurately identified 1, 2, or 3 article parts accurately identified	Not done
30	20	10	0

4. Article Summaries (3 total)

Easy to follow Clear, Concise, Accurate, Excellent work	Fairly easy to follow Relatively clear, Somewhat concise, Mostly accurate, Good work	Hard to follow Not clear and/or concise, inaccuracies evident Good attempt	Not done or unacceptable
30	20	10	0

5. Attention to Detail/Participation/Attitude
(e.g., title page, lettering, dates and sources clearly indicated, focused effort in class time allowed, positive attitude toward assignment)

Above average	Average	Below average	Project not submitted
10	7	3	0

TOTALS

1.	/20
2.	/10
3.	/30
4.	/30
5.	/10
Project Total =	/100

USE OF NEWSPAPERS AND PERIODICALS IN THE CLASSROOM

The teaching of science within explicit curricular emphases lends itself to the extensive use of articles from magazines and newspapers in the classroom. Suggestions for use include:

- Bulletin Boards can be assembled by students or teachers on various themes (page 61)
  - Science, Technology and Society
  - Career possibilities in Science and/or Technology

- Technology
  - Technologies grouped into such categories as sound, transportation, medical...
  - Daily news clips following a specified issue such as an oil spill, cold fusion developments, acid rain

- Classroom Activities
  - Collages on themes like science and technology (pages 42 – 43)
  - Introduction and practice of SQ3R reading technique leading to article summary or question assignments (pages 76 – 77)
  - Perspective identification assignments (pages 58 – 60)

- Projects
  - Scrapbook projects calling for collection of articles with specific purposes in mind, e.g., Technology in the News (pages 51 – 55)
  - Oral presentations backed up with visual displays of pictures and/or articles

- Hanging Files
  - Establish hanging files of articles on topics related to the curriculum
  - Consider collecting a series of articles on a particular issue, local articles where relevant, interest provoking articles to use as lead–in or follow–up
  - Use as material for individual of small group assignments or as enrichment material for students who finish daily activities early
  - Consider developing focusing questions and clear, simple assignments based on an article or series of articles clipped.

COPYRIGHT LAWS

Under the current copyright laws teachers require written permission to copy class sets of articles from periodicals or newspapers. The original article may be displayed as part of bulletin boards or be laminated for circulation in the classroom. Purchase of class sets of newspapers with relevant articles or sections may be desirable in certain circumstances. Purchase of class sets of newspapers, possibly when science sections appear, should be considered. The newspapers could be split up and used in cooperation with language arts and social studies teachers. The whole paper can be used in search and clip activities for various purposes associated with the curricular emphases.

Information as to the specific policies of the **Edmonton Journal** and **Calgary Herald** follows. Teachers are encouraged to contact their local newspaper representatives to determine their particular policy in regard to use of newspaper articles in the classroom.

The **Edmonton Journal** and **Calgary Herald** have provided the following information regarding their policies and procedures.

The Edmonton Journal

- All material written by **Edmonton Journal** staff writers **may be** duplicated in class sets.
- Any article not written by an **Edmonton Journal** writer would require written permission from the service agency concerned; e.g., CP, Reuters, King Features, Knight Ridder Newspapers. Addresses for these various service agencies can be obtained from public library reference sections.
- Extra copies of daily newspapers are kept for short periods of time and may be available upon request. A nominal charge is usually imposed.
- For further information, purchase of class sets, or requests for back issues, please contact:

  Education Services and Community Relations, telephone: 429–5175

Calgary Herald

- No material may be duplicated for class sets without written permission.
- Extra copies of daily newspapers are available upon request, while supplies last, **free of charge**. Special editions or high demand papers usually have a charge.
- For further information, to order back issues or class sets contact:

  Circulation Department, telephone: 235–7100

REVIEWING ARTICLES

Having students read articles in newspapers, magazines, and periodicals can be a valuable way of teaching them about the interactions among science, technology and society in Canada. Students will need some help in gleaning the most significant points from the articles.

The SQ3R Method (Robinson, 1970), outlined below, is an effective strategy for enabling students to summarize written material. When using the method, teachers should work through at least one article with the class to demonstrate each step and illustrate the usefulness of the whole process.

Survey: Skim the whole article first. Read the headings and sub–headings if there are any. Read the summary if there is one. Try to get a general idea of the content of the whole article. What are the main points?

Question: Think of the questions the article will likely answer. Write these questions on a separate sheet of paper. The headings in the article can easily be turned into questions. The questions will give your reading more purpose.

Read: Read the item carefully. Read to find the answers to the questions you have asked.

Recite: Go back over the article immediately. Ask yourself the questions you raised earlier. Write out your answers in short form.

Review: Sometime later, review the questions and answers. Quiz yourself. Reread the parts you have forgotten.

More detailed information on SQ3R is given on pages 76 & 77.

The point form outlines from an SQ3R analysis can be taken in for marking. The marking criteria could include the following points:

- questions for articles
- identification of main points
- completeness
- conciseness
- use of own words

PERSPECTIVE IDENTIFICATION IN ARTICLES

In any article on science, technology and science-technology issues, certain selected perspectives can be identified. An article may express several perspectives on a particular issue. Students can be involved in reading such articles and identifying specific perspectives. Common perspectives useful for identification are given on page 60.

Science 14/24 students will benefit from practicing a reading strategy such as SQ3R as background to such article analysis assignments, pages 76 – 77. Identification of one perspective within an article is a good starting point, gradually building up to two, three or more perspectives within one article.

The article on page 59 has been copyright cleared and can be used as a sample for introducing identification of perspectives in an article. This particular article has a strong scientific perspective, a political perspective and a minor technological perspective. The students can use SQ3R to read the article and then search for a selected perspective, underlining the appropriate section. Discussion of various opinions on the location of particular perspectives will most likely reveal that there is room for debate as some sections demonstrate more than one perspective, or can be interpreted in slightly different ways by different individuals. Through discussion a group consensus as to the location of the selected perspective should be reached, keeping in mind this is not a "cut and dried" determination.

Perspective Identification Exercise – Sample

Note:

- deal with one perspective at a time when introducing
- see perspective synopsis sheet, page 60

WHEN IT COMES TO WASTE, CANADA LEADS THE WORLD

OTTAWA (CP) — Environment Minister Lucien Bouchard finds Canadians are the most wasteful people on earth.	societal perspective (political)	Environment minister's statement
Bouchard on Thursday cited a study compiled by his Environment staff showing that Canadians even surpass Americans in the per–capita generation of waste. They also found that Canadians recycle less waste than any other country. The Japanese recycle between 50 and 60 percent of their waste. The equivalent figure in Canada is two per cent, said Bouchard. "If we would recycle our old newspapers on the Japanese level, we would save this country 80 million trees a year. The forest–management in Canada would be solved." The federal study found that Canadians generate 1.8 kilograms of waste per capita daily, compared with 1.63 kilograms for the United States, 1.1 kilograms for Switzerland and .77 kilograms for Norway.	scientific perspective	Results of studies done by Environment Canada, Statistics, comparisons, projections
Bouchard said many Canadian pulp mills lack proper equipment to recycle waste paper, and recycling programs are having difficulty getting rid of large quantities of waste paper collected from households.	technological perspective	References to equipment and processes required to remedy problem
"It jumps to the eyes of a lay person like me that we must achieve a policy where the pulp and paper companies will be obliged to take old stuff (and) recycle it," said Bouchard.	societal perspective (political)	Environment minister's statement as to direction government should take

Article from **Edmonton Journal**, May 12, 1989
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PERSPECTIVE SYNOPSIS SHEET

SCIENTIFIC PERSPECTIVE

- generally involves reporting what is currently known about some phenomena, what research is going on and what questions remain to be answered
- often reports data, analysis of data, observations, conclusions, results of studies or surveys done in a scientific manner

TECHNOLOGICAL PERSPECTIVE

- involves the discussion of solutions to practical problems
- talks about products or processes that satisfy human wants and needs
- may discuss past, present or future technology, or the research and development of a particular technology

SOCIETAL PERSPECTIVES

Political Perspective

- involves government policy or initiatives on any issue
- government officials, members of political parties or persons representing any level of government are more often quoted, representing their particular agency

Economic Perspective

- having to do with money – how much will it cost?
- involves costs related to a particular scientific and/or technological or STS issue; e.g., money required for research and development, estimated cost of a particular technology, costs associated with environmental clean-up associated with the use of a particular technology, project economic effect of a technology on certain workers

Environmental Perspective

- involves the examination of the effects of any factor on the environment

Legal Perspective

- involves the law; answers questions like: What is the law associated with this issue? What changes are being proposed or anticipated?
- may make reference to a particular law, to courts, to trials, to verdicts or judges' decisions

Ethical Perspective

- involves the discussion of what is morally right or wrong in regards to a particular issue, e.g., genetic engineering

BULLETIN BOARD

A bulletin board or tackboard may be used for displaying cartoons, charts, clippings, pamphlets, photographs, pictures, posters, student work, or other learning materials. Bulletin boards offer a wide range of possibilities for presenting visual material, and may be used in the classroom, corridor, library or other locations.

Since the Science 14/24 program emphasizes the interactions among science, technology and society; each unit lends itself to collecting newspaper and magazine clippings as well as current materials from local agencies. The relevance of the course to daily life can be emphasized by organizing the visual materials in the bulletin boards around the units in the course, e.g., news items on environmental concerns relating to Unit 3, in Science 14 or new technological developments relating to Unit 4. The class could also select a current issue (e.g., hazardous waste disposal) or a developing technology (e.g., telecommunications), and follow its discussion in the media for the semester or school year.

Alternatively, the bulletin boards could be organized around the headings "science," "technology" and "society" and the display items classified as they related to these areas. This approach is more generic and produces a bulletin board that can be used with other science classes that are taught in the same room.

GROUP ACTIVITY GUIDELINES

USING SMALL GROUPS IN THE CLASSROOM

The Science 14/24 program lends itself to groups of students working together on specific activities. Often they work in pairs but larger groupings may be more effective in particular circumstances.

To ensure that a small group activity achieves its purpose, students need to know what skills contribute to effective group functioning, and they need practice in using these skills. If students have had few previous classroom opportunities to engage in small group activities, the following suggestions may be helpful:

- In your own interactions with the students, model the collaborative processes and attitudes which you wish to encourage.
- Begin with sample activities carefully structured in terms of organization, time, task and outcome. Provide a written assignment sheet for each group. Appropriate activities might include: scientific investigations, scrapbook or collage assignments, preparation for oral presentation, library research, experimental design, debate preparation.
- Establish and maintain a consistent set of procedures so that students quickly learn what to expect. These may be in the form of guidelines which address topics such as: the formation of groups, physical arrangements, noise level, designated roles (e.g., chairperson, recorder), and reporting formats.
- At first, students will be more comfortable if the focus is on task rather than on group roles and interaction processes. Adolescents are easily inhibited when they feel that their interpersonal behaviour is under scrutiny. Once they have had successful experiences working in groups, however, they will benefit from an emphasis on the processes and strategies they employ.
- Focus evaluative comments and questions on the group rather than on individual students' contributions, and insist that students avoid making judgmental comments about each other.

INTRODUCING GROUP ACTIVITIES

Every group discussion activity should include the stages shown below:

Stages in Group Discussion

1. Identify the task. All members of the group should be clear on what they are to do, the time constraints and the form of the final product.

2. Preplan. Group members with special, specific responsibilities should be identified and all members should be reminded that everyone is expected to contribute.

3. Work together. Group members should work cooperatively, with consideration and respect for each other.

4. Finish the task. Groups should ensure that all materials or responses required have been developed, and be prepared to present these to the class.

5. Follow-up. Students should be prepared to discuss not only the final product, but the quality of the process. Periodically a fairly formal assessment of the group process and individual contributions should be made. The evaluation should be designed to improved the process and product, not to punish or criticize. The question should be: how can the process be improved? Students should also be led to recognize that the group is often capable of doing a better job than any one individual would do.

SPECIFIC TECHNIQUES

Small groups may be formed for a variety of purposes. Group activities can encourage student cooperation and create a climate of acceptance and support. They may encourage students intimidated by larger audiences to air feelings and ideas that could not be voiced in the larger class situation. They can be used to brainstorm ideas, to explore topics, to solve specific problems, to analyze data, to investigate and evaluate alternatives, to reach consensus, or to plan oral or written presentations. Suggestions related to three specific types of activity – brainstorming, problem solving and decision making – are included here.

Brainstorming

Brainstorming is an enabling strategy rather than an end in itself. It can be used to generate ideas or alternatives for activities such as problem solving, decision making, written or oral expression. Regardless of the particular purpose or context, brainstorming activities follow the sequence which is shown in the following chart.

Adapted with permission from *Enhancing and Evaluating Oral Communication in Secondary Grades*, Ministry of Education, Province of B.C., 1988

Steps in Brainstorming

1. The leader poses the problem or topic.

2. Students are encouraged to suggest whatever comes to mind and all responses are recorded without any commending or condemning statements by the recorder. (Teachers who are aware of the importance of giving immediate feedback to students often have difficulty resisting the temptation to comment on responses.)

3. As responses subside, the leader poses questions to stimulate further ideas. Often the best ideas surface at the end of the session when minds have been emptied of common or usual responses. Prompts might include "Is there any way we could combine two of these ideas to come up with something new?" or "Can anyone think of a strange of unusual...?" "Let's review the ideas one at a time and see if any of them make us think of other possibilities."

4. Once a brainstorming session has been completed ideas can be organized in a diagram or chart for further use. They may also be evaluated and classified. The way in which the ideas produced by the brainstorming session are handled will be dictated by the purpose for which the ideas were originally generated.

Brainstorming offers an effective means of introducing or reinforcing the concept that the shared efforts of a group can result in ideas or solutions that no one individual working alone could create. Brainstorming activities allow students to express themselves in a non–judgmental atmosphere where all responses are accepted and all students have opportunities to share their ideas – quantity rather than quality of ideas is stressed.

Problem Solving

Thinking strategies and language skills develop in concert: one informs and reinforces the other. Collaborative problem solving develops language strategies related to predicting and logical reasoning. In turn, as students become increasingly competent in communicating their predictions, their plans, their reasoning and their conclusions, they become more effective problem solvers.

> The mental and linguistic act of doubting, speculating, hypothesizing, questioning and seeking answers . . .[is] a major use of language in everyday learning; and it is a basic human resource we need to exploit in our classrooms (Fillion, 1983, p. 707).

Problem solving can involve a variety of oral interactions – pairs, small groups or the whole class – and variously require students to engage in brainstorming, discussion, decision making, or role–playing. Opportunities for group problem–solving activities occur in all areas of the curriculum. The qualities of a stimulated problem are outlined in the following.

Adapted with permission from *Enhancing and Evaluating Oral Communication in Secondary Grades*, Ministry of Education, Province of B.C., 1988

Qualities of a Stimulating Problem

- Must be interesting enough to challenge learners to want to find a solution
- Occurs naturally within the context of topics or themes with which the students are dealing.
- Matches the conceptual understandings and skills of the students.
- Allows for a variety of valid strategies although some may be more direct and efficient than others.
- Can be adapted, extended or related to other problems.

While the process of solving a problem is fluid and dynamic, rather than sequential and linear, groups should be made aware that four stages of activity are required.

Stages in Problem Solving

1. Understanding the problem. (Read, discuss and ask questions for understanding.)
2. Solving the problem. (Discuss and experiment with possible strategies; work toward a solution . . .)
3. Consolidating the problem. (Check and report answers; discuss solution(s), strategies, and features of the problem . .)
4. Extending the problem. (Recall related problems, invent similar problems, create new problems . . .)

(Morris, 1986, p. 14)

Teachers can enhance group problem-solving processes through strategies such as:

- Modelling appropriate problem-solving behaviour – describing and identifying strategies, participating in the problem-solving process with the students, and demonstrating patience, persistence and flexibility in working toward a solution.
- Encouraging participation and challenging students to work toward solutions by posing questions such as:
  - What happens when . . .?
  - If . . . what will happen to . . .?
  - What do you think is causing . . .? What could you do about it?
  - Why are you . . .?
  - What else could you try?
  - What will happen if . . .?
  - Do you think that would work for other problems? Why? Would you have to do anything differently if . . .?

Adapted with permission from *Enhancing and Evaluating Oral Communication in Secondary Grades*, Ministry of Education, Province of B.C., 1988

- Encouraging students to take risks and to regard mistakes as instructive – useful steps in finding a solution

- Focusing responsibility for solutions on the group rather than on individual students. Students thus feel free to take risks and cooperation and communication are fostered.

- Encouraging students to discuss the strategies they use so that they come to find values in their own resources. Questions such as the following can prompt such reflection:

Questions for Group Awareness

- What did you try first? How did your group decide to do that? What other things did you try?
- Did you have all the resources you needed? What else might have helped?
- What was your final solution? What was the most important step in getting there?
- What was the most difficult part of this activity?
- How did your group get along working together? What did you do that made things easier? If you were going to work together again, what would you change?

Decision Making

When students engage in group decision making, they become purposeful listeners and speakers. They state positions and respond to others' views, and become involved in the processes of making conscious rational decisions, examining values, empathizing, and reflecting on experiences so as to be able to generalize from them. Such activities help them to confirm that their own values and beliefs are valid and relevant to the classroom, and encourage them to respect the values and opinions of others.

A decision–making model, shown below, can be useful in planning and implementing group activities. It is important to keep in mind that the process is dynamic – effective decision making rarely occurs in discrete, carefully sequenced steps. Refer to the decision–making model, page 24.

Stages in Group Decision Making

1. Identify a problem or issue.
2. Identify possible solutions or objectives.
3. Gather, analyze and interpret information regarding the alternatives.
4. Evaluate and priorize alternatives to reflect information gathered or value preferences.
5. Test the priorities and analyze the consequences of each.
6. (Optional) Take some action on the group's decision.
9 Evaluate the group's decision.

Adapted with permission from *Enhancing and Evaluating Oral Communication in Secondary Grades*, Ministry of Education, Province of B.C., 1988

Topics for decision making should evolve naturally from other classroom activities and discussion.

Qualities of a Stimulating Decision Making Topic

- Relevant and interesting to the students. It should involve them in real issues with which they can identify.
- Appropriate in terms of adolescent development – it should not require students to deal with concepts they cannot understand or apply strategies they have not yet acquired.
- Lends itself to alternative solutions or decisions.
- Presents an issue about which there is uncertainty and disagreement. It is unrealistic to expect students to become involved in the decision–making process when there is really no decision to be made.

Adapted with permission from *Enhancing and Evaluating Oral Communication in Secondary Grades*, Ministry of Education, Province of B.C., 1988

Group Effectiveness Appraisal Form

Name:________________________________ **Group:**________________________________

Rate your group on a 1 to 5 basis (1 = poor; 2 = fair; 3 = good; 4 = very good; 5 = excellent):

1.	We worked cooperatively with all group members.	1	2	3	4	5
2.	We accomplished what we set out to complete.	1	2	3	4	5
3.	We were satisfied with our performance of this task.	1	2	3	4	5
4.	We used our group time efficiently without wasting or misusing time.	1	2	3	4	5
5.	We all contributed fairly in the completion of this group task.	1	2	3	4	5

Personal assessment and observations

1. Did you feel satisfied with your own participation in the project? Discuss your feelings honestly.
   ____...

2. Do you think that the project participation was fairly equal (that is, do you feel others in your group worked well and contributed fairly)?________________________________...

3. Do you think there are some ways your group could have improved and therefore produced a better finished project?________________________________...

4. Did you like doing a project like this, or do you honestly prefer to work on your own? (Please answer explaining why or why not.)________________________________...

5. Please add any helpful comments you may think of:________________________________...

Adapted from *The Writing Process Using the Word Processor*,
Alberta Education,
Curriculum Support Branch, 1988.

TEACHING FOR THINKING

CREATING SCHOOL AND CLASSROOM CONDITIONS CONDUCIVE TO THINKING

"The Key to Education Lies in Respecting the Student" Ralph Waldo Emerson

There are many claims by researchers that classrooms and schools are not conducive environments to stimulating thinking for students and for teachers. Teacher thinking is the invisible force that drives their performance and, thus, the climate for learning. It is equally important that conditions be created for stimulating teacher thinking as well as student thinking in all teaching/learning environments. Aspects of school and classroom conditions conducive to thinking are:

Stimulating Learning/Teaching Experiences: Thinking flourishes in an environment where questions are raised; problems are posed; paradoxes; dilemmas and discrepencies are resolved; and where there are opportunities to synthesize ideas into original responses and products. Opportunities to collaborate with others in problem–solving and task completion furthers thinking and understanding.

Openness: Thinking flourishes where it is valued and rewarded. There must be joy and respect for unusual ideas, unique responses, and outlandish questions. Without formal evaluation there is encouragement for original thought.

Discovery Time: Time is provided for, testing, questioning and experimenting with ideas without interruption. Time for playing with and discovering ideas without pressure to get the right answer allows risktaking and builds a climate of trust. Knowing it is okay to make a mistake and capitalize on the mistake in further investigation is essential.

Reflection Time: Wait time and reflection time are strategies both teachers and students use and respect. Time to discover and reflect on processes of one's own thinking are necessary. Unnecessary interruptions are removed and sufficient time to explore, discuss and ponder ideas are priorities.

Stimulating Resources: There is a need for a variety of enriching resources which stimulate inquiry and new ideas. Using a single textbook in the classroom can say there is only one source of information that is right.

Questioning Attitude: Open-ended rather than closed-ended questions are posed along with problems with no answers. A wide range of student responses can be generated. Students and teachers can freely test and challenge answers and freely inquire why they are doing a certain task. Teacher and student probing takes learning beyond the assigned topic and boundary of ideas. A spirit of inquiry is fostered and rewarded.

Freedom to Wonder and Predict: Learning and teaching experiences allow for supposing, posing possibilities and forecasting outcomes. Student intuitions and feelings are discussed.

Breaking Boundaries and Mindset: There are opportunities for examining, contrasting and evaluating ideas across disciplines. Investigating topics in greater depth, breadth, and in seemingly unrelated areas can bring broader understanding. Shifting perspectives and points of view can bring new ideas.

Self-Directed Activities: Students have input into learning experiences and make decisions and choices regarding their learning content, processes and products. Choices can be self–evaluated.

Adapted from *Teaching Thinking: Enhancing Learning*,
Alberta Education, Curriculum Support Branch: Draft May 23, 1989

Modelling Thinking: There are opportunities to observe others modelling good thinking strategies. Many opportunities to interact with others in solving problems and sharing ideas can expand strategies of thinking, learning and teaching.

Accomplishing some of the above conditions to set the basis for an environment that facilitates and encourages thinking is essential to further its development.

SUPPORTIVE TEACHER PRACTICES

Teaching thinking holistically involves integrating the imagination, feeling and inventiveness of a creative approach with the analyzing and evaluating of a critical approach. Alfred North Whitehead aptly directs us:

> **"After you understand about the sun and the stars and the rotation of the earth, you may still miss the radiance of the sunset."**

A blending of the critical and creative processes links thinking and learning to a real-life perspective. Teaching further involves decision-making, mediating, modelling and drawing upon a rich knowledge base of subject areas. In involves planning organizational patterns, teaching/learning strategies, and matching instructional processes. Teaching is a complex thinking process in itself, one of constantly assessing, redesigning and refining of direction.

Teaching strategies are patterns of instructional activities that when employed over time can achieve desired student thinking and learning expectations. The strategies grouped themselves into four distinct categories (Costa, 1985). Generic strategies like questioning, responding and modelling being common to all four catagories. The categories include:

- **Directive Strategies:** Teacher goals are directly presented, requiring students to reproduce the methods and the means of processing information. The teacher evaluates effectiveness.
- **Mediative Strategies:** Teacher sets the goals while students determine methods and means of achieving the goal. The teacher guides, while the student evaluates effectiveness.
- **Generative Strategies:** Goals are set by teacher and student with student deciding the means and method of processing information. The student evaluates effectiveness.
- **Collaborative Strategies:** Goals are set by the teacher and the group. The methods and means are determined by the group. The group evaluates effectiveness.

The general strategies of questioning, responding and modelling will be explored first with a discussion of directive, mediative, generative and collaborative strategies following. The general strategies may be applied somewhat differently in each of the specific strategies but are necessary to all.

QUESTIONING PRACTICES

> **"Children never give a wrong answer ... they merely answer a different question. It is our job to find out which one they answered correctly and honour what they know."**
>
> **Bob Samples**

Many years ago Socrates demonstrated the power of questioning to stimulate questioning. Educators today realize that questioning techniques influence the nature of student responses. Questions set the limits within which students can operate and the expectations for the degree and quality of information processing. Research reveals teacher questioning behaviours not only shape the level of student thinking, but also student achievement. Further investigations report that a majority of questions used in classrooms today require only factual responses and that students are not involved in thought provoking discussion. Information processing appears to follow the three phases described in the chart below. This process provides direction to planning questioning strategies.

Receiving Phase	Processing Phase	Applying Phase
• Information gathering • Recall of previous knowledge • Awareness of sensory attributes	• Manipulating information • Comparing, interpreting and analyzing new information • Comprehending and synthesizing ideas and their relationships	• Producing information • Evaluating and generalizing knowledge • Integrating concepts into new systems of relationships

If information taken in is constantly interpreted in terms of what is already known, little thinking occurs. As teachers pose discrepencies and problems, processing moves beyond the receiving phase to identify meaningful relationships and then transferring new realizations into actions.

Bloom and others have built a premise that levels of thinking are cumulative and build upon one another. The levels of thinking can cue the teacher to sequence questions throughout the information processing phases. Bloom's categories are described with sample questions:

KNOWLEDGE: **Identification of information.**
Describe__________ List __________.
Who, What, Where, When __________.
Recall everything you associate with __________.

COMPREHENSION: Organization and selection of ideas.
Explain in your own words __________.
Summarize the main idea of __________.
Define __________.

APPLICATION: **Use of facts, ideas and principles.**
Demonstrate the use of __________.
Interview __________ about __________.
How is __________ an example of __________?
How is __________ related to __________?

ANALYSIS: **Breaking information into its component parts.**
Examine __________ for similarities and differences.
Classify __________ according to __________.
Differentiate __________ from __________.
Outline/Diagram/Web __________.
What assumptions are necessary for __________ to be true?
What distinguishes __________ from __________?

Adapted from *Teaching Thinking: Enhancing Learning*,
Alberta Education, Curriculum Support Branch: Draft May 23, 1989

SYNTHESIS: **Restructuring information to create new ideas and concepts.**

Create/design ____________ to ______________.
Use the technique of ____________ to ______________.
What would happen if you combined to ________________?
Devise a solution for ______________.
Develop a plan to _______________.
Develop a theory to account for ____________ and ______________.
If ____________ is true then ____________ might be true.
Modify ____________ to ______________.
Extend ideas on ______________ to ______________.

EVALUATION: **Formulating judgements, opinions or decisions based on criteria or standards.**

How do you feel about ____________ as opposed to ____________?
____________ is right because ____________.
The ____________ evidence supports ______________.
Do you agree with ______________?
Prioritize ____________ according to ______________.
What criteria would you use to assess ______________?
I recommend ____________ because ______________.
What is the most important?
Is ____________ consistent with ______________?
Justify ____________.

As this is only one way to depict cognitive levels, teacher can create questions emphasizing other thinking processes. Although questions are posed at a particular level it does not guarantee students are processing at that level. Questions may have to be adjusted for students with inadequate data, guiding them to see relationships and proceeding to the more complex levels. For example, if a complex question like "What do you believe would be positive steps Canadians could take to prevent depletion of the ozone layer?" is too complex, it can be rephrased to "Why is the ozone layer being depleted?" or even "What is ozone? Why is it important to us?" All learners should have the opportunity to process information at all levels. What may vary is the length of time a student may require at a level. Different content and different objectives will also direct questioning. For example, direction might necessitate asking:

1. Quantity Question: **How many ways might** electricity be used in your home each day?
2. Forecasting Question: **What could happen if** cold fusion proves possible?
   If you were selected to improve your community's garbage handling **what would you say or do**?
3. Point of View Question: **How would** a total solar eclipse be interpreted by a tribesman in New Guinea or an astronomer?

As questions become more open-ended they invite greater thinking. It is important that student have input data, some concepts, and a range of sensory experiences to draw upon to begin manipulating and evaluating ideas. It is essential to pose processing, applying or higher level questions and organize such learning experiences to extend student thinking.

TEACHING FOR TRANSFER

Transfer is moving beyond the lesson. It is the carrying of a skill or knowledge to a new context. Driving a car does not insure one can drive a boat, a semi-trailer truck or a motorbike. There are many basic learnings from the original driving experience that would assist the task, but there are also gaps to bridge before the skill of driving becomes automatic in the next context.

Transfer, much as it is an educational expectation, does not occur easily. Skill and knowledge can be specialized and not always easily transferred. It appears to occur when surrounding attributes are similar and there is a perceptual similarity to the original learning. It also can occur when the learner abstracts a general rule or principle with the intent of using it elsewhere.

For example, to ensure the transfer of evaluating, a teacher might structure a situation very close to the original learning. In one instant the likes and dislikes of a situation were discussed and in the second the 'for and againsts' are discussed. On the other hand, if a broader transfer is desired, then the teacher can guide the learner to abstract the rules of evaluating and think about how that can be done when looking at a current political decision and determining its 'pros and cons'. By redirecting the attributes of evaluating, students can begin to see new connections and the benefits of a system of evaluating all ideas. The attributes of a skill need to be linked to the new context.

Analogies are useful strategies to redirect skill knowledge outside of the present context. Thinking skills, with some of their generic attributes, have the advantage of being able to cut across discipline boundaries. By guiding student attention and practice opportunities, patterns of good thinking can become more general in nature.

Adapted from *Teaching Thinking: Enhancing Learning*,
Alberta Education, Curriculum Support Branch: Draft May 23, 1989

TEACHING FOR THINKING IN SCIENCE

<table>
<tr><th></th><th>Scientific Investigations</th><th>STS Issues</th></tr>
<tr><td>Key Concepts</td><td>• to enhance understanding of the natural world</td><td>• to construct meaning of the relationships of science, technology and society.</td></tr>
<tr><td>Methodologies Prescribed</td><td>• Science process skills</td><td>• use of inquiry strategies in problem-solving and decision-making</td></tr>
<tr><td>Some Typical Thinking Skills Embedded</td><td>• questioning
• observing
• measuring
• researching
• inferring
• hypothesizing
• experimenting
• interpreting
• decision-making
• problem-solving</td><td>• analyzing
• patterning
• problem-solving
• decision-making
• predicting
• evaluating
• researching
• synthesizing
• questioning</td></tr>
<tr><td>Dispositions Often Developed</td><td>• explanations of natural phenomena</td><td>• many possibilities</td></tr>
<tr><td>Metacognitive Processing</td><td colspan="2">• clarifying (ask a teacher or peer to clarify a definition or relationship; struggling with contradictions, inconsistencies and misconceptions)
• verifying (raising questions about the adequacy of information)
• evaluating new ideas and testing them against prior knowledge
• revising earlier thoughts
• withholding judgements until all the information is in
• monitoring time and energy</td></tr>
<tr><td rowspan="2">Possibilities for enhancing thinking in subject area</td><td colspan="2">• more application to real life problems and situations</td></tr>
<tr><td>• more analyzing and composing of data
• more evaluation of processing
• more verifying of data
• more synthesizing of findings
• more decision-making opportunities</td><td>• verifying data from a broad range of sources
• expressing ideas from various points of view
• greater exploration of the sources of attitudes, beliefs and values of self and others</td></tr>
<tr><td>Teaching Strategies</td><td colspan="2">Greater use of Mediative, Generative and Collaborative Strategies</td></tr>
</table>

Adapted from *Teaching Thinking: Enhancing Learning*,
Alberta Education, Curriculum Support Branch: Draft May 23, 1989

RELATING COMMUNICATION AND CRITICAL THINKING SKILLS TO SCIENCE

CATEGORIES OF SKILL	SCIENTIFIC INQUIRY	DECISION-MAKING
Receiving Skills	Observing – obtaining information using the five sense	Interpret ideas and feeling of self and other (Participation Skills)
Thinking Skills	1. Initiation – identifying and defining problem; hypothesizing; designing collection data 2. Collection of data 3. Processing Data – classifying; measuring; interpreting 4. Conceptual of Data – developing a "mental mode"; predicting; controlling variables 5. Openendness – experimenting; applying knowledge; seeking further evidence; identifying new problems for investigation	1. Identifying and focus on the issue 2. Formulate research questions 3. Gather and organize data 4. Analyze and evaluate data 5. Synthesize data 6. Resolve the issue 7. Apply the decision 8. Evaluate the decision, the process and the action; begin inquiry anew
Expressing Skills	Communicating – describing objects, situations or events	Communicate effectively (Participation Skills)

Adapted from *Focus on Research*,
Alberta Education, Curriculum Support Branch, September 1989.

READING PROCESS

<table>
<tr><th colspan="2">I</th><th>II</th><th colspan="2">III</th></tr>
<tr>
<td>1. ESTABLISHING THE CONTEXT</td>
<td>2. FOCUSING ON THE READING TASK</td>
<td>3. READING AND COMPREHENDING THE SELECTION</td>
<td>4. RESPONDING, CONSOLIDATING MEANING</td>
<td>5. EXTENDING THE CONTEXT</td>
</tr>
<tr>
<td>1. Focusing prior knowledge
2. Building background</td>
<td>1. Forming intention
2. Anticipating meaning through prediction of the intention, content, and structure of a selection
3. Previewing the text in order to apply appropriate reading comprehension strategies</td>
<td>1. Experiencing the selection in a variety of ways
independent
guided reading
listening
2. Predicting, and confirming, changing or rejecting predictions
3. Actively interrogating the text by asking questions, finding answers, and making one's own comments
4. Reflecting on what is being read</td>
<td>1. Reflecting on what has been read
2. Responding personally and critically in a variety of modes
3. Organizing meaning for oneself
4. Sharing meaning with others
5. Clarifying and con–solidating meaning
6. Reshaping ideas and fom–ing new inferences
7. Developing literary and communication skills
8. Responding creatively</td>
<td>1. Extending students' experi–ences with ideas in the selection
2. Extending students' language experiences beyond the text</td>
</tr>
<tr>
<td>through
– experiencing and observing
– sharing personal experience
– brainstorming
– discussing
– writing about personal experience
– interviewing
– asking and answering questions
– reading
– drawing
– listening to music
– looking at slides, photographs, films
– creating charts, diagrams, mpas
– constructing models
– playing games
– role–playing</td>
<td>through
– asking questions (students' own)
– working in pairs or small groups to generate questions
– skimming for information gained from:
format
print signals
illustrations
– discussing organizational features of the selection
– reading a sense of how the selection is written
– using cloze procedures as a predictive technique
– using advanced organizers
– using group prediction activities
– webbing</td>
<td></td>
<td>through
– generating questions
– hypothesizing and sharing interpretations
– rereading selected passages
– presenting reheased oral readings
– making oral and visual presentations
– using discussions based on student–prepared questions
– retelling the story or parts of it
– dramatizing a story episode
– working out order of details
– determining meaning of individual words
– reading a whole paragraph to follow directions, provide a title for the paragraph
– using cloze procedures
– studying word meanings and structured features in context
– writing in a variety of formats
– examining features of style
– examining literary techniques</td>
<td>through
– reading related literature
– writing in a variety of forms (fictional, poetic, dramatic, documentary)
– viewing film, photographs, models, displays
– discussing ideas and experiences inspired by the selection
– representing in other media
– researching and reporting on self-selected or assigned topics
– reading for information
– organizing information by charting data
– interviewing and transcribing
– comparing and contrasting with other selections
– using puppets
– using improvisation or mime
– listening and responding to stories, poems, informational material, plays, music, conversations, environmental sounds presented "live" or on tape by teachers or students
– constructing models
– illustrating drawing</td>
</tr>
</table>

Adapted from *Focus on Research*, Alberta Education, Curriculum Support Branch, September 1989.

SQ3R

The SQ3R method can be applied to any reading for content assignment. It gives students an efficient tool to use in research projects, summarizing activities and when studying or reviewing. After mastering this technique PQ4R may be attempted, page 77.

The SQ3R Method (Robinson, 1970), outlined below, is an effective strategy for enabling students to summarize written material. When using the method, teachers should work through at least one article with the class to demonstrate each step and illustrate the usefulness of the whole process.

Survey: Skim the whole article first. Read the headings and sub-headings if there are any. Read the summary if there is one. Try to get a general idea of the content of the whole article. What are the main points?

Question: Think of the questions the article will likely answer. Write these questions on a separate sheet of paper. The headings in the article can easily be turned into questions. The questions will give your reading more purpose.

Read: Read the item carefully. Read to find the answers to the questions you have asked.

Recite: Go back over the article immediately. Ask yourself the questions you raised earlier. Write out your answers in short form.

Review: Sometime later, review the questions and answers. Quiz yourself. Reread the parts you have forgotten.

WHAT IS THE SURVEY Q THREE R METHOD OF STUDY? STUDENT HANDOUT

The SQ3R method is a means of study which outlines in concrete form some of the techniques you have already been using in your study habits, but it adds some techniques which you may not know. The Survey Q Three R method gives you a definite outline of a study procedure that has proven useful to those who practice it. Survey Q Three R has been developed and experimentally shown to be successful at one of the major universities.

Why is it especially useful? Because it guides you into discovering the important facts and ideas that are contained in an assignment, and then it helps you by showing how you can best master and retain that knowledge, so that you are prepared for an examination.

Survey: Take a minute or two (only) to survey the whole assignment, to find out what it is about as a whole. Look for summaries.

Question: Ask yourself questions based on the test, using boldface headings, such as in Geology, "Types of Rocks," and turning them into active, questioning sentences, such as, "What are the types of rocks?"

Read: By now you are reading, not passively, but actively, with certain definite questions in mind, and attempting to answer these questions and to organize the material. Read only to the end of each headed section.

From *Teaching & Evaluating Reading in the Senior High School*, Alberta Education, 1988

Recite: Look away from the assignment and from any notes you have taken, and ask yourself the questions you have already made up. If you can answer them without looking at the book, you know the material at the present time. If you cannot answer them without going back to the material, you should go back and then try again.

Review: Review each headed section (briefly) as you complete it, and also review later on to keep from forgetting the material. Your understanding of it will be increased, too, each time you review. Go back over the material several times, if possible.

Additional sources of questions: 1 – charts and graphs. These are important summaries of material, and you should turn their headings into questions, if possible, or ask yourself questions about them.
2 – italicized phrases. These the author considers important, and you should too. As yourself questions about them.

Now repeat steps Question, Read, Recite, and Review on each succeeding headed section. That is, turn the next headings into a question, read to answer that question, and recite the answer, followed by a brief review. Read in this way until the entire lesson is completed. Question yourself from the chapter summary also.

Is the Survey Q Three R method an easy way to study? No, it is not. It is an easy technique to understand and to memorize, but it will call for deliberate effort on your part to practice these techniques regularly. It will not be easy to learn to apply it, because your old more passive habits of reading will interfere with the active effort to study at first. But you can learn to apply the Survey Q Three R method successfully, and you will find it rewarding.

PQ4R

1. Preview: Learners activate their prior knowledge by applying the preview step to reading assignments in content area:
   a. examine title
   b. read introductory statement thoroughly
   c. glance over subtitles, charts, tables, captions
   d. read summary statement carefully

2. PQ4R: Knowledge activated during the preview step is confirmed, bridged with new knowledge, reconstructed, etc.
   a. question
   b. read
   c. reflect
   d. recite
   e. review

3. Students use PQ4R to develop flexible schema shifting in response to sub–themes in textbook chapters.

HELP STUDENTS BECOME TEXTWISE

In order to help students approach the reading of school texts more effectively, Tierney and Pearson suggest that teachers might:

- alert students to the need to read the material carefully
- provide inserted questions or activities that encourage students to monitor their developing interpretation
- provide students with strategies such as outlining and note taking for carefully reading the text
- encourage students to consider their purposes, their level of understanding, and ways to monitor that understanding
- have students read the material in conjunction with carrying out some relevant activity.

In helping students and bring to reading their prior background in processing text, Tierney suggests that teachers should:

- encourage readers to relate their background of experience to what they read
- alert students to the importance of their own ideas, perspectives, and purpose in any communication
- ask students to discuss their knowledge, including a perspective about a topic, as well as discussing the author's perspective and what the author assumed the reader knew and might learn.

Much of the teaching of reading in specific content areas should be done with the actual textbooks the students are required to read. Reading instruction can be applied to real reading assignments the students have received in the content area class.

In helping students to become textwise, teachers will help them:

- become aware of headings and other features designed to aid comprehension
- develop means for dealing with unfamiliar vocabulary before and during reading
- read questioningly
- adjust reading speed to density of language structures
- skim for main ideas, then read and re-read as necessary to form concepts
- summarize, diagram, take notes, make marginal notations to aid comprehension and recall.

Rate of reading must be constantly related to reader purpose in reading a piece of material. For some kinds of reading, students may also need to be taught to close reading techniques, including:

- pre-reading activities: scanning headings, skimming for main ideas, relating relevant prior to experience to material to be read
- re-reading activities: going back over a passage until one is sure that the main idea is grasped
- note-making activities: summarizing a paragraph and then a section of material
- harting and diagramming as a means of understanding relationships between ideas.

Students should be taught to adjust their rates of speed in reading relative to their purposes in reading.

Many of the skills and approaches needed for good textbook reading can be taught through the SQ3R, page 76 or PQ4R methods, page 77.

From *Teaching & Evaluating Reading in the Senior High School*, Alberta Education, 1988

A WRITING PROCESS MODEL

The writing process model provides a useful structure for planning, discussing and examining writing for instructional purposes. It is useful for all subject areas where students are expected to write.

The writing process may be described as having three main stages: *prewriting*, *writing*, and *postwriting*. In reality, however, the writing process is not as clearly defined as these stages would imply. Writing is not a linear process; it is essentially recursive in nature, and the path through the process is different for each writer.

1. Prewriting

In this stage the writer prepares to write. A context for writing is created in the classroom, and students are helped to focus on the writing task.

Through activities such as brainstorming, discussion, reading and observation, students relate what they are planning to write to their prior knowledge, build the necessary background, generate and clarify their ideas, as well as identify the vocabulary needed to express these ideas.

2. Writing

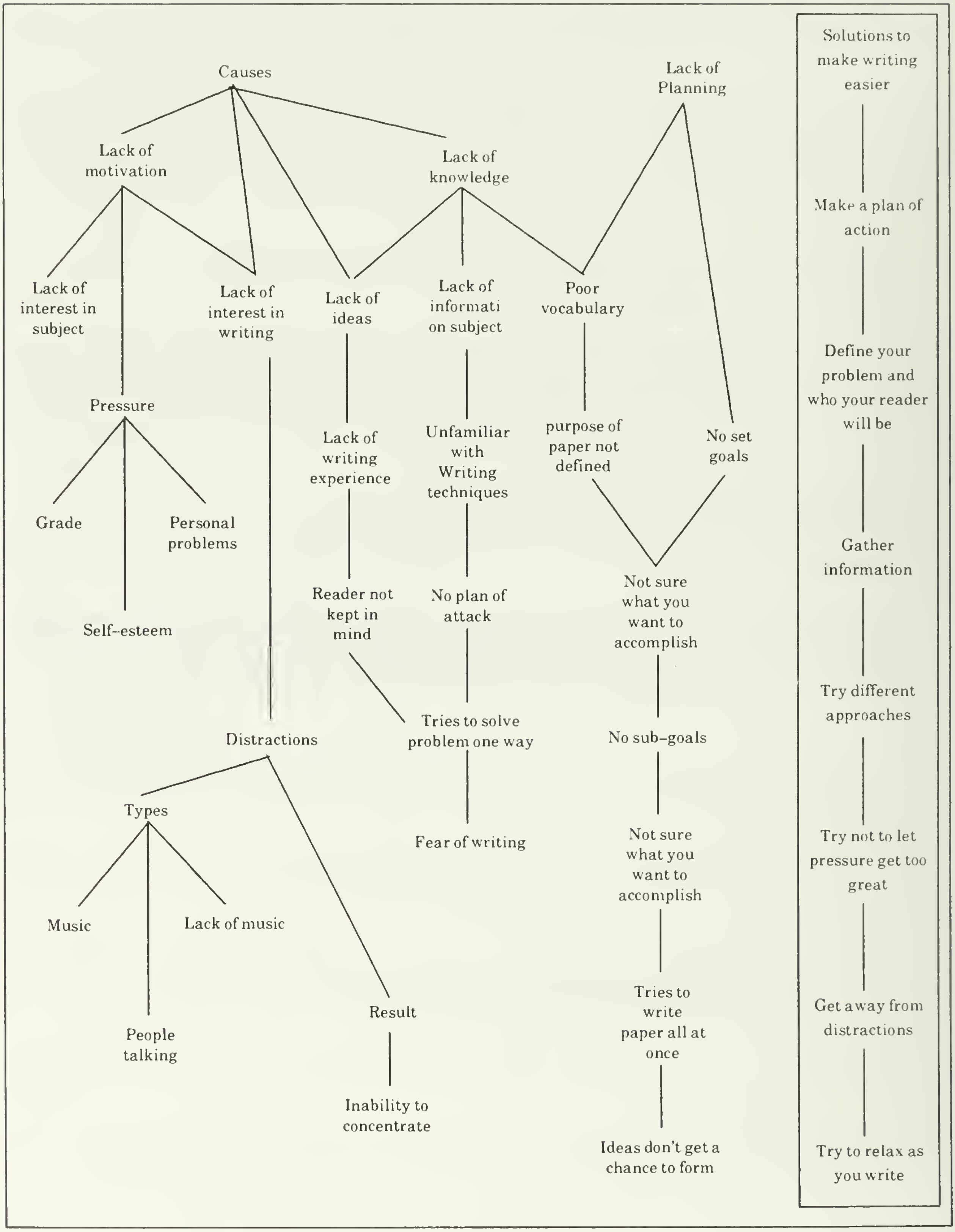
During the second stage the writer puts thoughts on paper in first draft form. This step of making meaning is central to the process of writing.

3. Postwriting

The third stage consists of revising and editing the writing. During this stage writers continue to rework their ideas and correct errors in sentence structure, grammar, punctuation and spelling. Celebration and publication of writing are an important part of this stage as well.

From *The Writing Process Using the Word Processor*, Alberta Education, Curriculum Support Branch, 1988.

What makes writing difficult?



From *The Writing Process Using the Word Processor*, Alberta Education, Curriculum Support Branch, 1988.

WRITING VARIABLES: USING RAFTS

(The following is adapted from materials developed for the Calgary Writing Project, and is used with permission.)

To assist young writers in developing their writing skills, teachers should provide discussion contexts and strategies for generating and organizing writing ideas.

RAFTS represents a system of focussing on the writing task. **RAFTS** can be extremely useful in helping a writer identify *role*, *audience*, *format*, *topic*, and *strong verb* when developing a piece of writing.

RAFTS gives the writer:

R a **Role** in which to do the writing. The role may be as intimate as oneself or as distant as that of an inanimate object.

A an **Audience** from whom the writing is intended. The audiences for writing may range as widely as the writer's role. Variation in audience necessitates variation in the register o f the language used.

F a **Format** in which to write. Writing formats can range from telegrams, to stories, to formal reports.

T a **Topic** about which to write. Topics need to relate to the role and audience selected.

S a **Strong Verb**, which aids the writer in vocabulary choice and in setting the tone of the writing.

These elements are combined in the **RAFTS** assignment format:

As a **Role**, write a **Format** to (an) **Audience**, strong **Verb**(ing) about a **Topic**.

You are a **Role**. Write a **Format** to (an) **Audience**, strong **Verb**(ing) about a **Topic**.

These examples illustrate how the **RAFTS** format can be used to create writing assignments:

- As a microscope, write a pamphlet explaining your function to members of an alien society.
- As a particular organ in a body system write a letter to another organ in another body system explaining how important you are to that organ; e.g., heart writes to lungs.
- You are a television viewer. Write a letter to the manager of the Public Broadcasting System network requesting a program on a particular science–technology related issue. Making your opinion on the issue clear.
- As a car, write a list of instructions for the driver promoting safe driving.
- As a bacterium, write a short poem emphasizing your important role as a decomposer.
- As a resonsible energy user, write a letter to your parents describing how energy could be used more efficiently in your home.

From *The Writing Process Using the Word Processor*, Alberta Education, Curriculum Support Branch, 1988.

- As a scientist, write a series of four entries in your diary describing your thoughts for a new research project on __________.

- You are a microwave oven (telephone, stereo system). Write a memo to your operator complaining about mistreatment.

- As Minister for the Environment, write an announcement of a new government program to reduce the use of bleached paper in Canada.

- You are a visitor on the planet Earth. Write a postcard to your friends at home describing a specific technology (specific environmental problem).

The sample variables for RAFTS outlined on the following page are not meant to be a comprehensive list, but rather suggestions to teachers and students in the brainstorming process. Teachers can prepare **RAFTS** assignments for students, or they can show students how to write their own assignments.

Students can brainstorm **RAFTS** variables as a class, in groups, or alone, and create their own **RAFTS** lists.

From *The Writing Process Using the Word Processor*, Alberta Education, Curriculum Support Branch, 1988.

Sample Variables for RAFTS

Role

- self
- cat
- friend
- alien
- hunter
- secretary
- policeman
- grandmother
- machine
- fur coat
- jogger
- reporter
- sportswriter
- mircowave oven
- robot
- sea monster
- historian
- scientist
- astronaut
- pioneer
- ghost
- detective
- princess
- Prime Minister
- Old Inuit
- taxpayer
- Czar Nicholas
- Edgar Allen Poe

Audience

- self
- mother
- coach
- babysitter
- girlfriend
- T.V. set
- architect
- bigot
- feminist
- principal
- banker
- editor
- employer
- fans
- hockey star
- dog owners
- complaint department
- classmates
- S.P.C.A.
- cartoonist
- bicycle
- tooth fairy
- ghost
- earthlings
- kidnapper
- rock band
- immigrant
- publisher

Format

- diary
- cartoon
- letter
- interview
- script
- pamphlet
- bumper sticker
- recipe
- code
- report
- sonnet
- note in bottle
- parchment
- funeral oration
- invitation
- conversation
- resumé
- news report
- song
- tall tale
- postcard
- fary tale
- newspaper ad
- commercial
- resignation
- editorial
- friendly letter
- soliloquy

Topic

- accident
- conservation
- importance of sportsmanship
- undone homework
- job qualifications
- unleashed dogs
- being great
- pioneer life
- hockey game
- junk food
- eviction
- first public performance
- clean up room
- buried treasure
- neglect
- strange creatures on a distant planet
- haunted house
- wage increase
- used car
- mouse for lunch
- granting of a wish
- persecution
- character portrayal
- poor spelling
- saving energy
- story ending
- magic
- rights of a nine–year–old

Strong verb

- denying
- inquiring
- appealing
- analyzing
- persuading
- appreciating
- cozxing
- questioning
- complaining
- justifying
- pleading
- dreaming
- inviting
- arguing
- bragging
- apologizing
- imagining
- promoting
- warning
- condemning
- thanking
- advising
- honouring
- describing
- teaching
- announcing
- complimenting
- disbelieving

From *The Writing Process Using the Word Processor*, Alberta Education, Curriculum Support Branch, 1988.

LISTENING PROCESS

An Instructional Model

I – Prelistening

1. ESTABLISHING THE CONTEXT

1. Focusing prior knowledge
2. Building background

through
- asking questions
- interviewing
- brainstorming
- reading about topic
- learning about speaker
- familiarization with speaker's dialect, style, etc.
- viewing materials about topic
- using manipulatives
- sharing personal experiences
- predicting non-verbal behaviours from audiotapes
- making word associations

2. FOCUSING ON THE LISTENING TASK

1. Forming intention to listen
2. Determining potential value of message
3. Anticipating meaning through predicting
   - speaker's intention
   - message content and organization
4. Expecting vocal and/or non-verbal cues to meaning
5. Anticipating speech style differences (e.g., spontaneous talk, written language read aloud)
6. Considering role in terms of context (e.g., size of audience, formality, purpose)
7. Determining relationship to speaker in order to respond appropriately
8. Understanding personal biases

through
- role-playing
- simulations
- webbing/clustering/mapping
- listing questions speaker might address
- writing predictions in learning logs
- listening to tape of speaker on similar topic

II – Listening to the message

3. LISTENING AND COMPREHENDING

1. Attending
2. Filtering out distractions
3. Focusing on selected stimuli
4. Predicting meaning
5. Getting meaning from phonological syntactic, and semantic sources
6. Using vocal, non-verbal, and visual cues to meaning
7. Adjusting to speaker's register
8. Summarizing continuously through inner speech
9. Following speaker's sequence of ideas
10. Selecting relevant details
11. Understanding main idea of message
12. Evaluating message critically
13. Appreciating speaker's style and language use
14. Making personal associations
15. Understanding speaker's point of view
16. Providing appropriate feedback (e.g., supportive stance, eye contact, gesture, comments)
17. Setting aside personal biases

III – Postlistening

4. RESPONDING AND CONSOLIDATING MEANING

1. Expressing personal understanding of message
2. Associating message with personal experiences, beliefs, attitudes, and feelings
3. Making inferences
4. Asking questions to clarify message
5. Comparing personal perceptions and understandings with those of others
6. Drawing conclusions
7. Recalling, clarifying, and organizing personal meaning
8. Remebering information using appropriate strategies
9. Evaluating ideas critically
10. Responding appropriately

through
- generating questions
- retelling
- writing in response journals
- examining features of speaker's style/language use
- paraphrasing
- dramatizing
- cartooning/illustrating
- writing in different formats
- discussing/challenging
- shaping/comparing interpretations
- finding supporting evidence

5. EXTENDING THE CONTEXT

1. Extending experiences with ideas in the message
2. Extending language experiences beyond message

through
- discussing related issues
- drawing/sketching
- dramatizing
- role-playing
- reading/listening to related literature
- debating
- performing puppet plays
- presenting orally on the same topic
- developing visual material
- writing and performing a song
- researching and reporting
- planning and taking field trips
- transcribing talk (e.g., conversation, dialogue, reports)

Adapted with permission from *Enhancing and Evaluating Oral Communication in Secondary Grades*, Ministry of Education, Province of B.C., 1988

Debating

Debating provides an excellent opportunity to develop the speaking and listening skills of all students. With careful, focused instruction most students can learn to debate in any desired style. Debating is an enjoyable and educational experience for all students which can offer a new world of intellectual challenge. Before any debates are presented, students should be given a chance to practice some of the skills that will be needed. Experiences in speaking, speaking in groups, reporting to the class – will all help reduce anxiety and making debating a pleasurable activity.

Introducing Debating

Teachers should be sensitive to values and attitudes of their local communities when selecting debate topics. In addition, several guidelines should be observed to produce effective debatable resolutions:

- Use a positive statement. Negative words in a resolution coupled with the forms "affirmative team" and "negative team" may confuse debaters and they could end up arguing the same side.
- Focus on <u>one</u> central idea.
- Use clear, precise wording. Otherwise, the debate may focus on definitions or on unrelated issues.
- Use neutral language.
- Be sure there are valid arguments on both sides of the resolution.

Qualities of a Stimulating Decision Making Topic

- Relevant and interesting to the students. It should involve them in <u>real</u> issues with which they can identify.

- Appropriate in terms of adolescent development – it should not require students to deal with concepts they cannot understand or apply strategies they have not yet acquired.

- Lends itself to alternative solutions or decisions.

- Presents an issue about which there is uncertainty and disagreement. It is unrealistic to expect students to become involved in the decision–making process when there is really no decision to be made.

Topics for decision making should evolve naturally from other classroom activities and discussion.

Stages in Group Decision Making

1. Identify a problem or issue.
2. Identify possible solutions or objectives.
3. Gather, analyze and interpret information regarding the alternatives.
4. Evaluate and priorize alternatives to reflect information gathered or value preferences.
5. Test the priorities and analyze the consequences of each.
6. (Optional) Plan a course of action.
7. Establish a group decision.
8. (Optional) Take some action on the group's decision.
9. Evaluate the group's decision.

Adapted with permission from *Enhancing and Evaluating Oral Communication in Secondary Grades*
Ministry of Education, Province of B.C., 1988

Debating Styles

Classroom Debates. These formats can help students to acquire and practice debating skills in a relatively informal and supportive situation.

- Cruchly Format

  One–half of the class is assigned to affirmative; the other half to negative. After preparation and research, the groups take turns presenting their arguments. Each student may speak only twice. Scoring is based on quantity of argument and supporting evidence and effectiveness of rebuttal.

- Informal Contest

  The class is divided into four teams; each team is assigned a topic but must prepare both cases. (Sides of the argument are assigned immediately prior to the debate.) Each person may speak only twice. Groups assign speaking, recording and rebuttal roles. Scoring is based on quantity of arguments and evidence, and effective rebuttal.

Horseshoe Debate

A horseshoe debate is a highly structured simple debate format that lends itself very well to the study of STS issues. Many skills can be developed using this strategy, including:

- critical thinking in assessing a variety of viewpoints and considering alternatives before making a decision
- applying a decision–making strategy to an issue
- communicating effectively and with confidence orally.

In addition, attitude objectives can be addressed such as developing an appreciation of the relationship among science, technology and society, and developing an awareness of the ethical dilemmas that can arise from technological developments.

To identify an issue, the teacher might use a newspaper clipping to review a recent event such as the announcement by the Alberta government of plans to build several pulp mills in northern Alberta. The teacher could then ask, "What restrictions should the provincial government place on the operation of pulp mills built in Alberta?"

Adapted with permission from *Enhancing and Evaluating Oral Communication in Secondary Grades*
Ministry of Education, Province of B.C., 1988

1. To help students with other steps in the decision-making process, the following chart might be used:

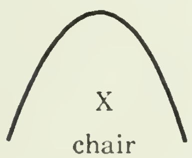
PROBLEM OR ISSUE: What restrictions should the provincial government place on the operation of pulp mills built in Alberta?	
Alternatives	Pros + and Cons –
1	+ –
2	+ –
3	+ –
4	+ –
My decision(s) on the problem/issue is	My reason(s) are

Students would engage in research activities in order to complete the chart.

2. After students have completed their research and formulated their decision(s), they prepare their opening statement for the <u>horseshoe debate</u>, using their decision(s) and their reasons as the basis of their initial statements.

This debate itself is organized in the following manner:

- Arrange desks in a horseshoe



- Initial Statements
  - students present their opening statements within a three minute time limit
  - as others listen, they note questions, challenges, etc.

- Open Round
  - going around the horseshoe again, students ask questions of others, refute points or arguments, add additional support or detail to their own positions, or pass
  - this continues until no one wishes to speak, or time runs out

Note: to facilitate participation and to prevent too much overlap or repetition, it is advisable to have approximately 15 students per debate.

EVALUATION

Students should be made aware of the components and expectations of the evaluation strategy at the start of the activity.

Students would be evaluated on their participation in the debate, using a scoring sheet like the following:

Name________________________	Exc. 5	Good 4	Avg. 3	Fair 2	Poor 1	Comments:
Emphatic statement of opinion in both introduction and conclusion						
Support of opinions with specific facts and examples						
Ideas expressed clearly, logically						
Relevant questions asked in rebuttal						
Facts, details and reasons given in defense of position or in rebuttal						

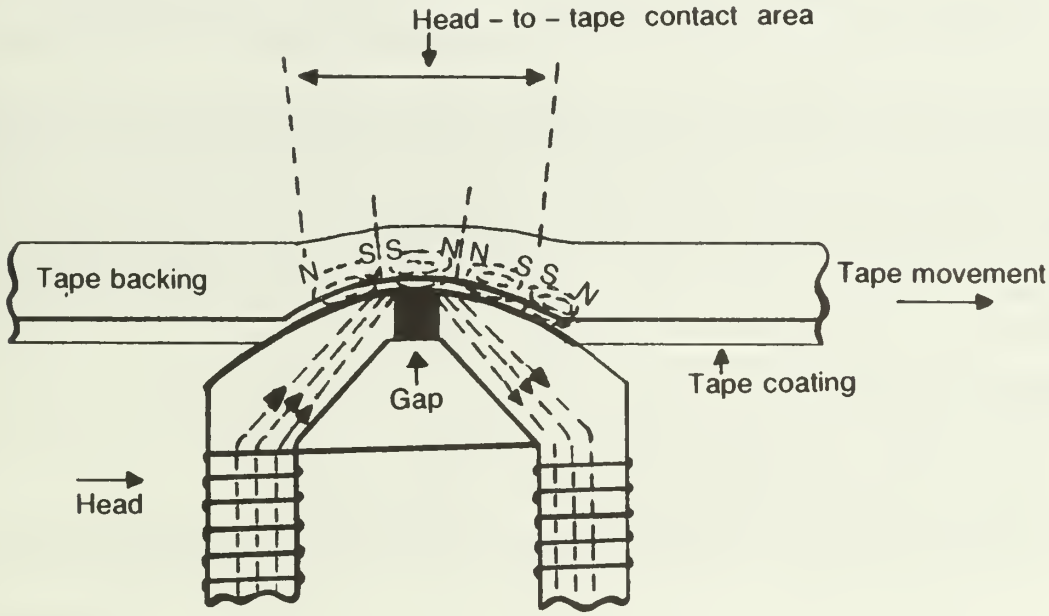
PREVIEWING AND POSTVIEWING ACTIVITY SAMPLE

Acme School of Stuff – Cassette tape segment (approx. 10 minutes)

Not the Sounds of Silence. . . Cassette Tapes

The recording or sound has long been of interest to us. Edison constructed the first phonograph around 1877, but it is only in the last 30 years that we have seen dramatic changes. This new recorder is the tape recorder with tape cassettes. And even now this has been superseded by a new technology—the compact disk.

The early recorders kept a record of a series of sound variations in the magnetization along a metal wire. Today, we have tape coated with a ferric material. The information is stored by magnetizing this coating on the tape. The information (sound, music) is put there by a microphone connected to an electromagnet, and sound is converted into an electric current which causes a changing magnetic field in the elctromagnet of the recording head. These changes are then recorded on the tape by the recording head. To play the tape back, this tape record passes over the electromagnet (playback head) and causes a changing voltage across it. This voltage causes a current which in turn activates a speaker through amplification. This process is simply the reverse of the earlier recording process.

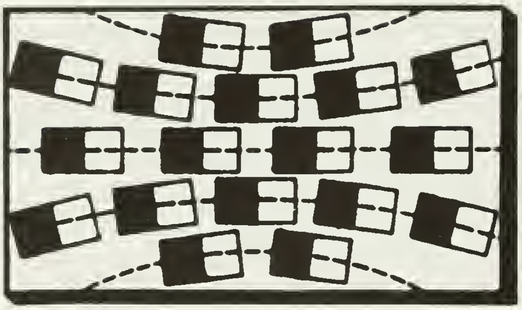


Generally a faster and wider tape produces better frequency response and is able to store more detail. Hence, the quality of sound is better.

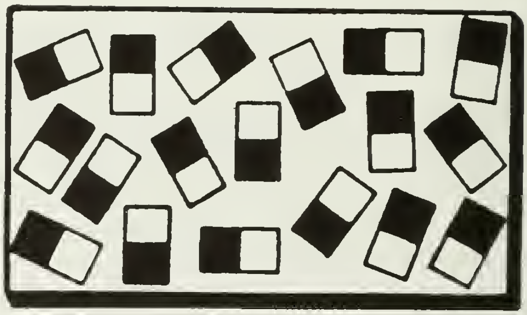
Stereo recorders require two input microphones and each is recorded on a separate track on the tape, hence two parallel tracks. Most tapes today have two tracks on each side of the tape so that it can be turned over and played immediately.

How does it work?

Magnetic materials contain little entities called "domains" that are distributed randomly. When these materials are placed in a magnetic field, the domains line up along the magnetic field lines.



a. In a bar magnet, the domains align themselves so that their effects add up to produce a magnetic field.



b. In a non-magnet, the domains are arranged at random, thus cancelling their magnetic effects.

An electromagnet is simply a permanent magnet with a current–carrying wire wrapped around it. A changing current causes a second magnetic field, and the combined fields become much stronger.

Music or voice can cause a changing current which results in a changing magnetic field. This magnetic field is recorded by the domains in the magnetic tape and kept there. To replay, the magnetic record (tape) is drawn across the inert electromagnet; the magnetic changes cause a voltage, a current, and finally an active speaker. The tape can be reused simply by erasing the memory from the tape.

Suggested Activities

1. What substance is used to record the "sound" now?
2. Why does faster-moving tape record "sound" more accurately?
3. Why do we need two tracks for stereo?
4. Why don't you have to rewind your cassette when you turn it over?

LIBRARY RESEARCH STRATEGIES

The Science 14/24 course offers numerous opportunities for student research activities. This research section provides a research model and guidelines for teachers. Short and simple research projects are recommended as a starting point with Science 14 students. Begin using the strategies in the introductory teacher–directed column (pages 94–102,) focusing on the actual methods of research while dealing with a science topic. As research skills develop students can challenge longer and more comprehensive research assignments, moving into the advanced, student–directed research activities columns.

Two sample research projects for units in Science 24 have been provided, one for Unit I, Disease Defence, and one for Unit IV, Safe Transportation (pages 103–109.) The data collection sheet provided can be used for any research project and closely parallels the SQ3R strategy presented earlier. The sample research activities have been kindly provided by:

Margo Johnston	Gloria Hodgetts
Teacher–Librarian	Teacher–Librarian
Jasper Place Composite High School	M.E. LaZerte Composite High School
Edmonton, Alberta	Edmonton, Alberta

We gratefully acknowledge their contribution to the research strategy component of this manual. It is hoped such research activities will be, wherever possible, cooperative efforts of science teachers, teacher–librarians and/or language arts teachers.

LIBRARY RESEARCH AND THE SCIENCE PROGRAM

The first step a scientist or technologist takes in solving aproblem is to collect all the information that bears on the question. The information may be collected from a variety of sources, including research reports, periodicals, conference presentations or discussions with colleagues. When such information collection is not effectively carried out, the result is often duplication of research and general wasted effort. For example, during one 10–year period 250 of the 950 new antibiotics reported in the literature were in fact duplicated discoveries.

The use of the library in the science program models for students one essential part of science work: using the literature of science to increase one's knowledge of the world. Scientists who wish to advance scientific knowledge begin with a survey of what those before them have achieved. Scientists acknowledge with Isaac Newton that new knowledge is possible because "we are standing on the shoulders of giants."

As science teachers we model what it is to be a scientist in the laboratory; we should also model what it is to be a scientist in the library.

FOCUS ON RESEARCH

Focus on Learning, published by Alberta Education in September, 1985, outlines an integrated program model for school libraries.

The integrated model focuses on involving students in the planned and purposeful use of library resources. It is designed to help students grow in their ability to gather, process and share information.

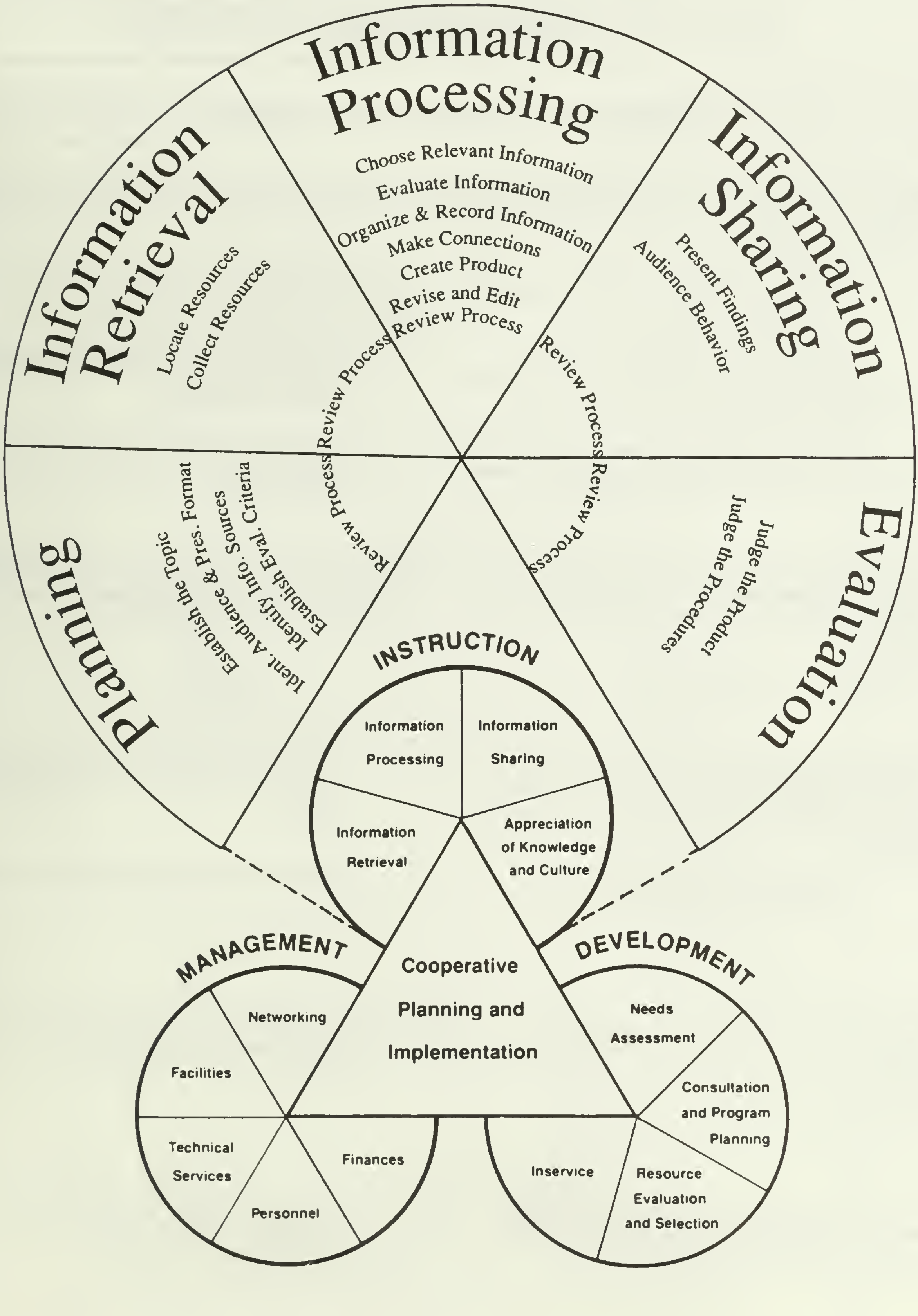
The ability to deal effectively with the proliferation of information is more essential now than at any other time in history. In order for information to become personal knowledge, students have to make connections and see relationships between what they read, see or hear and what they know. They need to learn a comprehensive research process which can be applied in any subject area and in real-life situations.

Developing skills to deal effectively with information will prepare students to function fully in society and will contribute to their appreciation of learning as a lifelong process.

This document outlines a model with which students can manage information efficiently and effectively. It provides a developmental approach to teaching students how to do research – component of the instructional component of ***Focus on Learning***.

This monograph supports the **Goals of Schooling** established by Alberta Education, specifically, "students will be provided with the opportunities and means to:

- develop competencies in reading, writing, speaking, listening and viewing;
- develop the learning skills of finding, organizing, analysing and applying information in a constructive manner; and
- acquired knowledge and develop skills, attitudes and habits required to respond to the opportunities and expectations of the world of work."


Information Processing
Choose Relevant Information
Evaluate Information
Organize & Record Information
Make Connections
Create Product
Revise and Edit
Review Process
Information Retrieval
Locate Resources
Collect Resources
Information Sharing
Present Findings
Audience Behavior
Planning
Establish the Topic
Ident. Audience & Pres. Format
Identify Info. Sources
Establish Eval. Criteria
Evaluation
Judge the Product
Judge the Procedures
Review Process
Review Process
Review Process
Review Process
INSTRUCTION
Information Processing
Information Sharing
Information Retrieval
Appreciation of Knowledge and Culture
Cooperative Planning and Implementation
MANAGEMENT
Networking
Facilities
Technical Services
Personnel
Finances
DEVELOPMENT
Needs Assessment
Consultation and Program Planning
Resource Evaluation and Selection
Inservice

FOCUS ON RESEARCH

Planning

	Introductory — Teacher Directed →	Advanced — Student Directed
Establish the Topic	• Teacher develops with students an understanding of the purpose for the research. • Teacher determines topic or provides limited options. • Students share exprience and knowledge of the topic. Teacher may introduce topic with resources. • Teacher helps students develop and organize questions to guide research.	• Students establishes purpose for the research. • Students chooses a specific topic. • Students clarify the topic by examining what they already know and/or consulting general information. • Students develop research questions which focus on new areas of knowledge and applications.
Identify Information Sources	• Brainstorm as a class for sources of information.	• Students survey information resources in the school and community.
Identify Audience and Presentation Format	• Teacher determines audience and presentation format. Students should be introduced to a variety of formats over time. • Teacher introduces format for collecting information.	• Students consider how size and character of audience affects choice of presentation format. • Students choose data collection format.
Establish Evaluation Criteria	• Students are made aware of expectations of the assignment.	• Students understand or help develop evaluation criteria for both process and content.
Review the Process	• Teacher reviews and records the research plan for the whole class. (See Appendix A)	• Students review the process and develops individual plans to guide research. (See Appendix A)

FOCUS ON RESEARCH

Information Retrieval

	Introductory Teacher Directed →	**Advanced** Student Directed
Locate Resources	• Teacher and library personnel identify useful resources.	• Students use standard tools for locating information such as: - card or computer catalogue - encyclopedia indexes - magazine indexes - bibliographies - computer data bases - on-line data bases - phone and other directories - community resource lists
	• Students are taught the skills of using standard location tools as appropriate beginning with card or computer catalogue, encyclopedia and magazine indexes.	
	• Students are given the terms or key words to be used for searching.	• Students generate possible search terms using standard thesaurus or subject heading lists.
Collect Resources	• Find a variety of appropriate and accessible print, non-print and community resources such as: - books - magazines - filmstrips - video tape - people to interview	• Students find a variety of print, non-print and community resources including such specialized materials as: - almanacs - yearbooks - subject-specific handbooks - dictionaries - atlases - encyclopedias - subject-specific periodicals - demographic yearbooks - biographies - anthologies - current event sources - computer databases - data banks - on-line sources - resource agencies - CD-ROM sources
	• Teacher and students follow routines required to borrow resource materials from their school libraries.	• Students access resources from different libraries and outside sources (e.g., special resource collections, community resources and agencies, special libraries, professional societies and associations, service clubs, museums, galleries, science centres, and other sites).
	• Students learn to use audio-visual equipment as necessary e.g., audio cassette recorders, video cassette recorders, overhead projectors.	• Students use a variety of equipment independently or with minimal assistance e.g., computer data bases, laserdiscs, on-line sources.

FOCUS ON RESEARCH

Information Retrieval

	Introductory Teacher Directed →	Advanced Student Directed
Review the Process	• Teacher and students review the materials collected and make a preliminary list of resources. • Teacher discusses with students whether there is sufficient information to answer the research question.	• Students review the type and quantity of resources collected and prepare a working bibliography. • Students determine if further information is required or if research plan needs to be revised.

Focus on Research (3rd draft), July 1989,
Curriculum Support Branch, Alberta Education

FOCUS ON RESEARCH

InformationProcessing

	Introductory → Teacher Directed	**Advanced** Student Directed
Choose Relevant Information	• Students read, listen, and view to answer the research questions. • Teacher provides instruction in appropriate strategies such as: - Skimming - Scanning - QSR (Question, Skim, Read) - TAR2 (Tune in, Analyse, Respond, Review) - Interpreting maps, graphs, and pictures.	• Students read, listen and view to gain pertinent information about the topic. • Students chooses and uses strategies appropriate to the resources being used.
Evaluate Information	• Distinguish between fact and fiction.	• Students distinguish between fact and fiction, between fact and opinion, between fact and theory, between fact and value, between hypothesis and evidence, and hypothesis and generalization.
	• Consider accuracy and currency of source.	• Students determine authority and reliability of source.
	• Recognize consistency of information.	• Student recognize author's point of view, bias, and underlying assumptions.
Organize and Record Information	• Students make notes using words or pictures to complete a simple outline, chart, or web.	• Students make notes using appropriate models such as diagramming, mind-mapping, retrieval charts, or note cards.
	• Teacher provides a format to record simple bibliographic information (author, title, copyright date, media type).	• Students record information needed for bibliography, footnotes and direct quotes, according to standard form.
Make Connections and Inferences	• Teacher helps students make generalizations and state relationships between concepts.	• Students develop a thesis statement.
	• Students combine information to answer research questions.	• Students formulate alternative answers, solutions, conclusions or decision to a problem.

Focus on Research (3rd draft), July 1989,
Curriculum Support Branch, Alberta Education

FOCUS ON RESEARCH

InformationProcessing

	Introductory Teacher Directed	**Advanced** Student Directed
Create the Product	• Teacher provides instruction to enable students to create an appropriate medium for presenting ideas such as: - simple report from notes and/or a student and teacher generated outline. - simple illustrations, charts or graphs. - models, dioramas, murals, tape recordings.	• Students create an appropriate medium for presenting ideas such as: - a multiple paragraph composition using appropriate structures for introducing, developing and concluding a topic. - visual materials such as maps, charts, graphs, pictures, illustrations or timelines. - film, slides, or video tapes.
Revise and Edit	• Students with the assistance of teacher or peers review information to delete repetitive and irrelevant information. • Edit and/or rehearse presentation with teacher and peer assistance. • Check for vocabulary, sentence structure and mechanics.	• Students re-examine information for relevance to intended focus and format. • Edit with peer assistance. • Check for cohesion and mechanics.
Review the Process	• Teacher and students reflect upon the research steps and share experiences.	• Students reflect upon experiences and make generalizations for future use.

FOCUS ON RESEARCH

Information Sharing

	Introductory Teacher Directed →	**Advanced** Student Directed
Present Findings	• Students present information to a partner or small group within the school. • Students demonstrate presentation skills with attention to format, purpose and audience (e.g., quality, layout, titles, colour, spacing, visibility, volume, clarity, vocabulary, expression, introduction, conclusion, evidence of rehearsal).	• Students present to individuals, groups, classes within school and to individuals and/or groups out of the school. • Students demonstrate increased presentation skills for sharing information, with attention to format, purpose, and audience to now include pitch, enunciation, pace, handling of questions and technical understanding.
Demonstrate Appropriate Audience Behavior	• Students demonstrate appropriate social skills. • Students ask appropriate questions.	• Student demonstrate empathetic listening behaviors. • Students demonstrate an ability to develop followup inquiries.
Review the Process	• Teacher and students make positive, constructive comments.	• Students respond to or summarize a presentation in paragraph or point form.

Evaluation

	Introductory → Advanced	
	Introductory Teacher Directed	**Advanced** Student Directed
Judge the Product	• Teacher uses checklists and evaluation criteria.	• Teacher uses evaluation criteria. • Students use predetermined criteria for self-evaluation.
Judge the Research Procedures and Skills	• Teacher uses checklists to assess extent to which research plan was followed. • Students take part in conferencing with teacher and/or teacher-librarian.	• Students, individually or with peers, identify and evaluate research steps. • Students take part in conferencing with peers, teachers, and/or teacher-librarians.
Review the Process	• Teacher reviews with students specific suggestions indicating what could be done to improve research (e.g., using more resources, using different media for sharing research findings).	• Students analyse, teacher, peer and self-evaluation to identify strengths and areas for improvement, concentrating on process and content statements.

STUDENT RESEARCH PLAN

A STUDENT RESEARCH PLAN:

- Requires student to summarize major procedures that he or she will follow in researching a topic.

- Contains those elements that are determined by the teacher or teacher-librarian and those determined by the student.

- Provides reference points to guide student research.

- Serves as a checklist for teacher or teacher-librarian to ensure that it is appropriate and that the student has a good chance of succeeding.

- Gives a focus for self-evaluation procedure.

- May include such information as:
  - student's name and grade
  - study theme
  - topic or thesis statement
  - sub-topics for research
  - resource needs
  - subject headings and cross references for search
  - final presentation format and materials and equipment needed
  - guidelines or requirements
  - intended audience (e.g., teachers, individual students, various groups in class or school, individuals or groups outside school)
  - evaluation criteria for process and content
  - timelines
  - approval (if required) through conferencing with teacher or teacher-librarian

SAMPLE

STUDENT RESEARCH PLAN

NAME/SUBJECT/GRADE: *Rob Matherson / Language Arts / Grade 7*

THEME: Communication / Messages

TOPIC STATEMENT: I'm going to research how dolphins communicate. I will find out how they make and receive sounds and what the sounds mean. I will also cover research being done with dolphins and how it might help man to communicate with them.

SUB-TOPICS:
1. Dolphins - Message Sending
2. Dolphins - Message Receiving
3. Research with Dolphins
4. Man / Dolphin Communication

RESOURCES:
- Books in School Library
- Magazines (World?)
- Videos/Films (National Geographic)
- West Edmonton Mall Trainers

SUBJECT HEADINGS: Dolphins, Porpoises, Animal Communication, Mammals, Oceans, Marine Life?

PRESENTATION FORMAT AND NEEDS:
- poster board (assigned)
- instructions with assignments, write up, and 3 - 5 minute talk
- need markers, glue or tape, get poster board from teacher or teacher/librarian

GUIDELINES: 200 - 250 - word minimum, illustrations, bibliography, poster board, 5 questions for group

AUDIENCE:
- 3 other students in class (teacher to pick)
- teacher
- displayed

EVALUATION:
a) notes - 10% (teacher)
b) plan - 10% (teacher/teacher-librarian
c) poster board - 20% (teacher-librarian)
d) presentation - 20% (other students and self)
e) information and language arts skills - 35% (teacher)
f) bibliography - 5% (teacher)

TIMELINE:
a) start - November 4
b) topic or subtopic - November 5
c) research done - November 8
d) rough copy - November 12
e) final copy - November 14
f) presentation - November 15

CHECKED AND APPROVED: D. Fielding November 5/89

SCIENCE 24 UNIT I DISEASE DEFENCE
RESEARCH PROJECT

by Gloria Hodgetts and Margo Johnston

Suggestions to teachers for organizing this library research unit:

1. Have each student report on a different disease.

2. Have students work in groups on different diseases. (Each individual is responsible for certain aspects of the research)

3. Have students make a poster, bulletin board display or other visual to share.

4. Set up a station approach with sources on each disease and have students work in groups to do each station. To share this information, each group picks one personal to sit on a panel and go through research questions. Open the floor to questions. Anonymous questions can be handed in.

5. Students may use the attached Research Data Collection Sheet for each source used, page 106.

POSSIBLE RESEARCH TOPICS

1. Allergies
2. Aids
3. Anemia
4. Arthritis
5. Asthma
6. Bronchitis
7. Cancer
8. Chickenpox
9. Coeliac disease
10. Colitis
11. Common Cold
12. Cystic Fibrosis
13. Cystitis
14. Diabetes
15. Eczema
16. Emphysema
17. Epilepsy
18. Food poisoning
19. German measles
20. Gonorrhea
21. Hemophilia
22. Hay fever
23. Heart disease
24. Hepatitis
25. Hernia
26. Hodgkin's disease
27. Influenza (flu)
28. Jaundice
29. Kidney disease
30. Leukemia
31. Malaria
32. Multiple sclerosis (MS)
33. Mumps
34. Osteoporisis
35. Parkinson's disease
36. Pneumonia
37. Psoriasis
38. Rabies
39. Scarlet fever
40. Shingles
41. Smallpox
42. Syphilis
43. Tetanus
44. Thrombosis
45. Typhus
46. Trichomoniasis
47. Tuberculosis
48. Ulcers
49. Varicose Veins
50. Whooping cough

Courtesy of Gloria Hodgetts and Margo Johnston
Teacher–Librarians, Edmonton Public Schools

FOCUS QUESTIONS FOR RESEARCH

Research one disease. Your research should contain the answers to the following questions:

1. Is the disease communicable or non–communicable? (*If non–communicable go to question 5.*)
2. What are your chances of getting the disease?
3. Is the disease caused by a virus or bacteria?
4. How can you become infected?
5. Is it related to an allergy? How? (*If no proceed to question 6*)
6. What are the chances of you contracting this disease?
7. Can diet have an effect?
8. What are the causes?
9. Describe the symptoms. (What happens?)
10. How is the disease controlled or prevented?
11. When was the disease discovered and by whom? (*If known*).
12. What is the treatment or cure?
13. Has there been any new research or technological developments (last 10 years) that may help in coping with this disease? Describe them.
14. How serious is this disease?

Courtesy of Gloria Hodgetts and Margo Johnston
Teacher–Librarians, Edmonton Public Schools

RESOURCE LIST

To locate material on DISEASES

REFERENCE BOOKS

Encyclopedias
Health encyclopedias
e.g., Family Health & Medical Library. 18 v. Kensington New South Wales, Australia: Bay Books
Illustrated Encyclopedia of Family Health. 24 v. London: Marshall Cavendish, 1983.
ISBN 0-86307-127-9 (set)

BOOKS, NON-PRING MATERIAL, CLIPPINGS:

To locate books, clippings, pamphlets, non-print, etc. look in the SUBJECT CATALOGUE under the name of the disease.

PERIODICALS:

To locate materials in magazines, use indexes such as READER'S GUIDE TO PERIODICAL LITERATURE AND THE CANADIAN PERIODICAL INDEX.

RESEARCH DATA COLLECTION SHEET

Topic Chosen: ______________________________
____

Source used: ______________________________
____

Procedure:

S(skim) 1. Look at the source you have selected. Survey the table of contents, pictures, graphs, maps and index. Get a general idea about what the source contains.

Q(question) 2. Think of questions which are likely to be answered by using this source. Turn each heading into a question. Ask who? What? Where? When? Why? How? Write these questions

____
____
____
____
____
____

R(read) 3. Read the appropriate sections in your source to answer your questions. Jot down the key points.

a)______________________________
____
b)______________________________
____
c)______________________________
____
d)______________________________
____
e)______________________________
____

R(recite) write 4. Use the above information to write a rough copy of your paragraph for your topic.

____
____
____

R(review) revise 5. Check for errors and then revise. Rewrite the paragraph.

Courtesy of Gloria Hodgetts and Margo Johnston
Teacher-Librarians, Edmonton Public Schools

SCIENCE 24 UNIT IV: SAFE TRANSPORTATION RESEARCH PROJECT

Instructions:

Use a source to locate information about one of the above topics. Follow the instructions given on the research data collection sheet, page 106. You will be required to hand in your completed data collection sheet with your final paragraph. Be prepared to present a short oral report to the class, on your topic (approximately 2 minutes).

Possible Research Topics

1. Pedestrian safety
2. Use of daytime driving lights on vehicles
3. Advantages of seat belts
4. Types of seat belts and restraints available (infants and adults)
5. Which cars (models) are the safest and why?
6. How to travel safely in a car with young children.
7. Emergency procedures for preventing accidents.
8. Accident statistics (Alberta) and their interpretation
9. Importance of traffic lights for safety; e.g.,
   - railroad lights
   - crosswalk lights
   - school bus lights
10. Fire safety
11. Safety and recreational vehicles
12. Motorcycle safety
13. Used vehicle safety check program
14. Bicycle safety
15. New safety devices re: drinking and driving
16. Major causes of death for under 20–year–olds
17. How does driver education help prevent accidents
18. Defensive driving
19. First aid
20. What are the legal implicatons of impaired driving charges?
21. Consequences of traffic accidents?
   - legal
   - spinal cord injury
   - other medical injuries
   - property damage
   - graph (statistics)
22. Load distribution as related to accidents (transport trucks)

Courtesy of Gloria Hodgetts and Margo Johnston
Teacher–Librarians, Edmonton Public Schools

Resource Materials

Resource materials for Unit IV, Safe Transportation research topics are available from:

Alberta Alcohol and Drug Abuse Commission (AADAC)
Community Education Services
8th Floor, 10109 – 106 Street
Edmonton, Alberta T5J 3L7

Phone: 427–4267
Note: Out of Edmonton contact your nearest AADAC office.

Alberta Solicitor General
Communications Branch
10th Floor, John E. Brownlee Building
10365 – 97 Street
Edmonton, Alberta T5J 3W7

Phone: 427–7245

Alberta Transportation and Utilities
Motor Transport Services
Planning and Statistics and Safety Education
4999 – 98 Avenue
Edmonton, Alberta T6B 2X3

Phone: 427–7912

PAID
Box 7244
Station "M"
Edmonton, Alberta T5E 6C8

Phone: In Edmonton 424–2321
In Lethbridge 381–1721

A sample list of titles available free from the organizations listed above:

Alberta Gets Tough On Impaired Drivers
Alberta Traffic Collision Facts 1987 – new edition is available yearly
Alcohol in Alberta
Canadian Motor Vehicle Traffic Accident Statistics, 1986
Cycle Edmonton
Daytime Driving Lights: Fleet Operators' Guide
Do You Want to Bet on a Sure Thing? (Driver Education)
Do You Want to Go for Broken? (Motorcycle Safety)
The Essentials of Child Car Safety Seats
Following a Spinal Cord Injury. . . How Can the Canadian Paraplegic Association Help?
Get Visible: It's Better to be Seen Sooner. . . than Later

HLDI: Injury and Collision Loss Experience
The Human Collision
If you Drink, Think!
If Your Car Could Talk . . .
Infant and Child Restraint Systems
Keep Them Safe
Light Up Your Life
Minimize Your Impact during Recreational Vehicle Use
People Against Impaired Drivers
Professional Driver Improvement Course: Driver's Notebook
Profile – Alcohol in Alberta: Costs and Consequences of Alcohol Abuse
Profile – Impaired Driving
Recycle Vehicle Safety Check Program
Riding on Air
Self-Help Advice – Winter Storms – You and Your Car
Smashed: The Magazine on Drinking and Driving
Tagged for Life
What Not to Do on a Friday Night (or anytime)
What Seat Belts Do
Who's to Blame?
A Word to the Roadwise

Courtesy of Gloria Hodgetts and Margo Johnston
Teacher-Librarians, Edmonton Public Schools

TESTWISENESS: AN IMPORTANT INGREDIENT IN ASSESSING STUDENT PERFORMANCE

by Dr. Kim Onn Yap

Testwiseness is a term that's been coined to describe how good a student is at taking tests. This capacity is independent of the student's knowledge of the subject matter being tested.

Examples of lack of testwiseness abound. Many students do not read directions carefully or misread directions. Few students realize that guessing is almost always to their advantage, even when there is a penalty for guessing. Some may think that with a multiple–choice question it isn't necessary to read all the possible choices before answering.

Research shows that, in general, testwiseness produces a small but consistent difference in favour of students who are testwise. Given comparable knowledge and skills in the subject area, testwise students tend to score a little higher than those who are not testwise.

Research demonstrates testwiseness consistently improves test performance.

It is neither possible nor desirable to take testwiseness away from students who already have it. On the other hand, it is both possible and desirable to teach testwiseness to those who lack it. (Mehrens and Lehmann, p. 336).[1] The goal of teaching testwiseness is to help eliminate extraneous factors which might get in the way of students demonstrating what they know. It is not to make students look better than they really are.

There are several things a teacher can do to prepare students for testing. Let's consider these strategies individually.

<u>Preparing Students</u>

In preparing students for tests, several major points are noteworthy:

1. Prior to any testing, teachers should make sure that their students understand key words and phrases often used in directions questions. As pointed out in a recent testwiseness project (Michigan State Board of Education), some students may not know the meaning of,

according to the author	(the) main idea (is)
according to the passage	mainly
always	maximum
best	minimum
chiefly	most
(one may) conclude that	nearly
highest	never
implied	only
inferred	or
least	sometimes
lowest	

Also many students may not be aware that "always", "never", and "only" are words which often make a statement or a distractor false.

From *Teaching & Evaluating Reading in the Senior High School*, Alberta Education, 1988

2. A significant portion of performances on standardized achievement tests hinges on a strong vocabulary. For the average youngster, most vocabulary is learned in everyday contexts (novels, newspapers, magazines, television and radio, conversation). But for students whose environments have been characterized by deprivation of one kind or another, direction instruction on vocabulary is essential.

   Since linguists estimate that 60 percent of English words in relatively common use today are of Latin and Greek origin (Millman and Puak, 1969)[2]; one strategy for building vocabulary is to teach commonly used prefixes and root words, e.g.:

Prefixes:	a	(atypical)
	ab	(abnormal)
	hyper	(hyperactive)
Roots:	homo	(homogeneous)
	graph	(monograph)
	tain	(maintain)

3. Prior to exams, teachers can also offer common-sense advice:

   - Get a good night's rest
   - Stay away from stimulants and tranquilizers
   - Don't drink a lot of fluids
   - Don't eat a big meal
   - Get to school early

   During the test, students will find these practices helpful:

   - Concentrate
   - Don't talk
   - Find a comfortable spot
   - Listen carefully
   - Ask questions if you don't understand what a question means
   - Stay calm if you don't know the answers
   - Make an educated guess
   - Time yourself by making a mental note of what the time will be when you'll have five-ten minutes left so you can review your work
   - Starting with the first question or problem read the passage or problem all the way through and then carefully read all the answer choices for each test question
   - Don't puzzle more than a few seconds over any question or problem
   - On your second pass through the test, try the questions you couldn't answer easily the first time. Read each of these questions or problems again and all the answer choices, then see if you can eliminate some of them.

4. Students must be properly motivated to take tests. They should be aware of the importance of testing; purpose of testing; specific areas to be tested; the length of the test; date, time and location of testing; materials to bring; and arrangements for make-up tests.

Instead of saying "I'll never finish the test," the students should tell themselves, "Just take one step at a time."

In some cases, a pep talk by the principal, counselor or teacher may be helpful. Reinforcement in the form of preferred activity time or bonus/point system might also help.

From *Teaching & Evaluating Reading in the Senior High School*, Alberta Education, 1988

A few additional specific strategies:

Positive self-talk. Instead of saying "I'll never finish the test," students should tell themselves, "Just take one step at a time."

Reading the question before the passage. This strategy allows students to save time by looking for answers as they read a passage. Be aware, however, that this strategy requires a proficiency that many low-achieving students do not have.

Guessing. From a measurement standpoint, guessing is advantageous to the test-taker in most, if not all, cases. When there is no penalty for guessing, which is the case with most standardized tests, students can only gain by making informed guesses. And even when there is a penalty, **informed** guessing may still be advantageous.

Guessing should be discouraged, however, when test results are used solely for diagnostic purposes.

Anxiety Control. A low or medium level of anxiety may actually enhance test performance. Of most concern to teachers and measurement experts is debilitating anxiety which renders students unable to provide an accurate measure of their achievement. When this occurs, teachers should have the option of using alternative assessment methods (e.g., use of work samples and teacher observations) which are less likely to evoke anxiety.

<u>Providing Congruent Practice for Students</u>

For some students in our culture, test-taking is almost a way of life. For these students, sheer test-taking experience can have a positive impact on performance. It is essential, therefore, that all students be given congruent practice in test-taking. . .

<u>Summary</u>

Research demonstrates that testwiseness consistently improves test performance. For student assessment to be accurate—and fair—all students therefore need to be testwise. Teachers can help by knowing how to prepare students for testing, creating good test items, and providing congruent practice for students. Testwise students not only provide a more valid measure of achievement, but also feel better about taking tests and enjoy their school life more.

Notes:

1. Mehrens, W.A., and IJ. Lehmann, **Measurements and Evaluation in Education and Psychology**, (3rd ed.) New York: Holt, Rinehart and Winston, 1984.
2. Millman, J. and W. Puak, **How To Take Tests**, New York: McGraw Hill, 1969.

STUDENT EVALUATION

Student evaluation refers to any formal, recorded assessment of progress toward the attainment of the Learner Expectations within a course of studies. Such assessments can be formative, summative or a combination of these two. Evaluation data can assist in making decisions about teaching methods, content of instruction, classroom management, and grading.

Formative Evaluation is the ongoing determination of the student's attitudes, skills, or level of understanding. These determinations are diagnostic in nature and in no way affect the student's course mark. Instead they become part of an individual student record, designed to provide information useful to teacher and student in planning more effective strategies for learning. The teacher may find these assessments useful as background for appropriate comments on the student's report card.

Summative Evaluation is the determination of a mark for student performance which is to become an integral part of the student's final grade in a particular course. These determinations form the basic measures of achievement for an individual student in relation to attainment of learner expectations, determining the granting or withholding of credit or promotion. Unit tests and final exams are are obvious forms of summative evaluation. However, any activity that is graded and becomes a component of the final grade is summative in nature.

Combination Formative/Summative Evaluation occurs when an evaluation of student performance is used for two purposes. As an example consider a unit test in Science 14. Here the mark the student receives becomes part of the student's final grade and thus is summative for the student. The class results on that same test can be used by the teacher to determine such things as the effectiveness of the course of studies, the success of teaching with a new curricular emphasis or basic resource, or whether a class or particular student needs remediation, enrichment or extension activity for that unit. The unit test is then formative for the teacher. To be truly formative for the student a test must have the option of a re-write after critical review of the test and time allowed to master skills or concepts that were handled poorly.

Recommended Reading

How to Evaluate Progress in Problem Solving, National Council of Teachers of Mathematics, 1987
An Introduction to Item Writing, Student Evaluation and Records Branch, Alberta Education, May, 1989.

PLANNING STUDENT EVALUATION

Student evaluation requires careful planning and the development of appropriate evaluation criteria. When planning for the evaluation of students in the Science 14/24 course, the following suggested guidelines may be helpful:

- a long range plan for student evaluation should be developed and communicated to students, parents and administrators early in the term
- a general assessment of student attitudes toward science is encouraged with an attitude inventory administered before and after the course
- attitudes can be assessed after each unit, providing information facilitating improved teaching strategies
- evaluate the thinking processes of students as well as their conclusions, answers or products
- an early assessment, formal or informal, to determine the level of student skill and concept development in relation to each unit of study is desirable
- quizzes, tests or unit exams should be carefully constructed to evaluate skill and concept development within the context of the curricular emphasis of any given unit of study

- clear, concise evaluation criteria should be developed and communicated to students for any activity they will be evaluated on
- a large variety of evaluation techniques should be applied, including student self-assessment
- ideally some type of evaluation should occur every period
- every student need not be evaluated on every activity, every period, as workable rotation schemes can be developed
- evaluation techniques that are quickly and easily applied while the students are involved in skill developing activities are desirable
- regular and systematic evaluation provides the student and teacher with information valuable in determining appropriate learning strategies
- consider replacing a comprehensive final course examination with a broader range and number of evaluations applied within each unit and final unit tests
- the unit be completed for evaluation purposes with the final unit test
- explore various combinations of open and closed notebook examinations

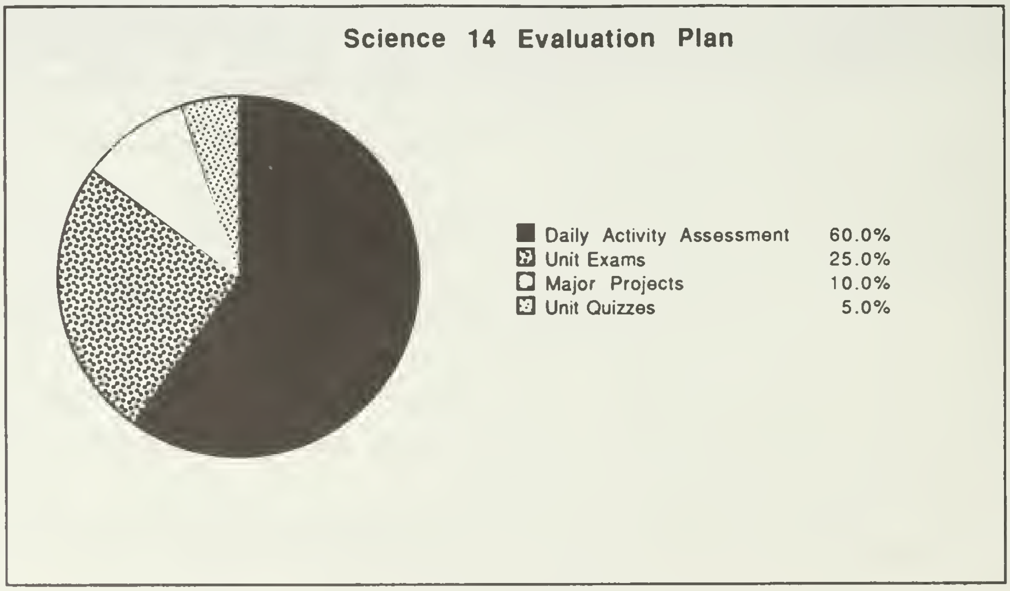
TYPES OF PLANS

1. Long-Range Evaluation Plan

Long-range plans should indicate clearly how students are to be evaluated for report card and final mark purposes. A general statement should be made with regard to weightings of the various components and an explanation of the components (page 119). Two sample plans follow: one represented as a circle graph and one in a matrix format. This plan covers only the summative evaluation of a student.

For evaluation purposes student participation will be interpreted as active engagement in the development of the skills set out in the learner expectations of the course of studies.

An outline of the formative types of evaluation to be used throughout the course should also be drawn up and appropriate instruments developed or obtained. Such plans should be communicated to students and parents along with the summative evaluation information.



EVALUATION MATRIX SCIENCE 14 LONG-RANGE (SAMPLE)

TOTAL %	Unit / Evaluated Item	I Body Systems	II Household Science	III Investigating the Environment	IV Understanding the Technology	V Elective Unit
60%	Daily Activity Assessment • problem-solving skills • participation • question completion & notebooks • projects, assignments • remedial, enrichment or extension activities	12%	12%	12%	12%	12%
25%	Unit Exams	5%	5%	5%	5%	5%
10%	Major Project	2%	2%	2%	2%	2%
5%	Unit Quizzes	1%	1%	1%	1%	1%

SCIENCE 14 LONG-RANGE EVALUATION PLAN

Sample General Statement

To the Student and Parents:

Sixty percent of the student's marks for the Science 14 course will be allocated to the daily activity assessment. Marks will be awarded for participation, satisfactory completion of daily activity assignments, and the development of problem-solving skills, specifically science inquiry and decision-making skills.

Students' responsibilities for Daily Activity Assignments will include:

- keeping of an organized and legible notebook

- satisfactory completion of questions associated with daily activities such as laboratory work, audio-visual presentations, minor research assignments, remediation, enrichment or extension activities, oral presentations by other students, discussions or debates

The remaining 40% of the student mark will come from specific unit quizzes, final unit tests, and a major project assigned for each unit. There will be no final exam for Science 14, only final unit exams.

Regular attendance, active participation, and a positive attitude will promote the skill and concept development essential for success in this course. When absence is unavoidable the student will be responsible for arranging with the teacher and/or other students to make up the work missed.

In addition to evaluations that result in a definite mark awarded to the student, assessments of student progress will be conducted to provide information to the teacher and student. No mark will be awarded for such assessments but the resulting information will be used to plan learning activities appropriate to individual students and the class as a whole.

If you have any questions or concerns regarding the Science 14 courses please phone *(name)* at *(number)*. Once you have read this course information please sign and date this page on the line provided and return with you son or daughter.

Signature ____________________ Date ____________________

2. Unit Plans

The unit plan is a more detailed description of the mark breakdown for a particular unit. It should be clearly communicated to students at the beginning of the unit. A sample unit evaluation plan for Science 14 follows.

EVALUATION MATRIX SCIENCE 14 UNIT PLAN (SAMPLE)

<table>
<tr><th>Evaluated Component</th><th colspan="2">Unit IV Understanding the Technology</th></tr>
<tr><td>Daily Activity Assessment

Problem–solving skills:
• science inquiry
• decision–making

Question completion and notebooks</td><td>40%</td><td rowspan="4">60%</td></tr>
<tr><td>Participation</td><td>10%</td></tr>
<tr><td>Projects, assignments</td><td>5%</td></tr>
<tr><td>Remedial, extension, enrichment</td><td>5%</td></tr>
<tr><td>Unit Exam</td><td colspan="2">25%</td></tr>
<tr><td>Major Project</td><td colspan="2">10%</td></tr>
<tr><td>Unit Quizzes</td><td colspan="2">5%</td></tr>
</table>

3. **Specific Activity Plan**

When a specific student activity is to be evaluated, guidelines for that evaluation should be established and communicated to the student. This gives the student a clear message as to what is expected and how it will be marked. Several examples of evaluation instruments for different evaluation techniques follow directly in the four sections of **Approaches to Learner Appraisal; Observing and Question; Student Self–Assessment; Holistic Scoring and Objective Evaluation.**

APPROACHES TO LEARNER APPRAISAL

OBSERVING AND QUESTIONING

Observing and questioning students while they are engaged in problem-solving activities can provide useful information about their attitude, skill and concept development. Observation and questioning can be done informally as you move about the room, or formally through structured individual interviews. Formal and informal techniques will be discussed in this section.

General Learner Expectations include seven categories of problem-solving skills which students are expected to continue developing within the context of the Science 14/24 course (pages 13–15). Science inquiry and decision-making skills called for in the Specific Learner Expectations of each unit are applications of these more global problem-solving skills. Observing and questioning students allows teachers to directly assess specific attitude, skill and concept development of students within a particular unit of study, and to judge the progress of students toward the General Learner Expectations on (pages 13–16.)

Informal Observation and Questioning

This method calls for the teacher to observe individuals, small groups or the class while they are actively engaged in a problem-solving activity. In Science 14/24 examples of such activities might include a scientific investigation, experimental design, model building, the identification of various perspectives on an issue, research on an assigned technology, or planning an oral presentation.

OBSERVATION TECHNIQUES

It is important that the students not be distracted by your presence. While they work in small groups or individually, move among them and observe how they work alone or together on a problem-solving activity. Observations should be focused. Limit observations to those aspects of performance and attitude that cannot be evaluated efficiently using other techniques. Select an individual or small group of students for observation and decide beforehand which aspects of their problem-solving behaviour you wish to evaluate. Be flexible enough to note other significant behaviour you may not have included in your original plan.

QUESTIONING

The purpose of the questioning is to help the teacher evaluate the student's problem-solving skills and attitudes. The questions asked should help reveal the student's thinking processes or feelings about problem-solving. For example, when students are working in pairs to design an investigation testing the effect of a selected stress on a particular body system, the questions might take the following form:

Adapted from *How to Evaluate Progress in Problem Solving*
National Council of Teachers of Mathematics, 1987

1. Can you describe the problem? What is it you want to investigate?

2. What do you think the investigation will show? Why?

3. How did (will) you decide which body function to investigate? Why did you select that particular body function?

4. What stresses did you consider testing? Why did you select this one?

5. Can you describe your experimental plan?

6. How will you record your data and what do you hope to do with it?

7. How do you feel about planning this investigation yourself?

8. Do you feel you can carry out this plan with your partner? Why or why not?

Such questions provide the insight you need to rate a student's problem–solving ability and attitude.

RECORDING TECHNIQUES

When observing and questioning students in problem–solving situations your findings should be recorded briefly, objectively and as soon as possible after observation. Suggested methods for recording include a comment card, a checklist, or a rating scale. Samples are provided below.

COMMENT CARD

Student: Jane Clarke　　　　Date: 7/1

Comments: Identified problem clearly but had difficulty in actual planning of the investigation. Uncomfortable with the prospect of having to design rather than follow a given plan. Cooperative in the group and responded well to guiding questions. Persevered with encouragement.

Adapted from *How to Evaluate Progress in Problem Solving*
National Council of Teachers of Mathematics, 1987

Checklist

Student: **Date:**

______ 1. Likes to solve problems

______ 2. Works cooperatively with others in the group

______ 3. Contributes ideas to group problem-solving

______ 4. Perseveres – sticks with a problem

______ 5. Tries to understand what the problem is about

______ 6. Can deal with data in solving problems

______ 7. thinks about which strategies might help

______ 8. Is flexible – tries different strategies if needed

______ 9. Checks data and/or results for accuracy

______ 10. Can describe or analyze results – come to an appropriate conclusion or decision

RATING SCALE

Student: **Date:** ____________________

	Frequently	Sometimes	Never
1. Selects appropriate solution strategies	______	______	______
2. Accurately implements solution strategies	______	______	______
3. Tries a different solution strategy when stuck (without help from the teacher)	______	______	______
4. Approaches problems in a systematic manner (clarifies the question, identifies needed data, plans, solves, and checks)	______	______	______
5. Shows a willingness to try problems	______	______	______
6. Demonstrates self–confidence	______	______	______
7. Perseveres in problem–solving attempts	______	______	______

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How do you develop such checklists and rating scales?

The examples above are only samples. They may be revised or used as guides to develop scales tailored to your needs. A general outline for creating them is described as follows:

1. Determine the goal(s) of performance or attitude you wish to evaluate. Select those that cannot be evaluated more easily by other means.
2. List specific student actions, thoughts, or attitudes that would indicate the achievement of the goal or goals.
3. Write items on the checklist or rating scale that describe the specifics in Step 2. (If a rating scale is used select an appropriate scale.)

Note that a checklist can include several goals, or it can be focused on a single specific learner expectation. Select those goals that cannot be evaluated more easily by other means.

Structured Interviews

This technique involves formal observation and questioning of a student during a problem–solving session. It is much more structured than the previously discussed informal methods, with a definite problem–solving task assigned and very specific questions to the student regarding the mental processes the student is going through and the feelings associated with such activity. A diagnostic interview plan must be designed to identify where a student is having difficulty, allowing for remedial planning. This method requires privacy, considerable time and effort, and a certain degree of rapport with the student. Recording of the interview on audio or video tape, writing an anecdotal report, or completing a rating scale or checklist is necessary to facilitate analysis. This formal method can be useful when other methods have failed to discover the student's difficulty.

How does one structure an interview?

The evaluator selects an assignment for the student to do during the interview. As an example of Science 14 student may be asked to identify the scientific and economic perspectives in a newspaper article on a recent oil spill. The SQ3R method has been taught in class and practiced at this point but this student is experiencing great difficulty in handling such assignments. A set of questions are then designed to probe the problem–solving strategy of the student and the feelings associated with the process. The areas the questions should explore are as follows:

1. Identification and understanding of the problem (investigation, issue, assignment)
   - Can you describe what you were (are) asked to do in this assignment?

2. Selecting and using appropriate strategies
   - What methods did (might) you use to do this assignment? What worked? (might work)
   - How did (will) you decide which method to use?

3. Selecting and using data
   - What specific information did (will) you locate and use from this article?
   - How did (do) you (intend to) use the information?

4. Solving or answering the problem
   - What steps did you go through in completing this assignment? (will you go through?)

5. Determining the reasonableness of the solution (deciding if the end result is appropriate)
   -When you finished (finish) how did (will) you decide your assignment was (is) reasonable?

Adapted from *How to Evaluate Progress in Problem Solving*, National Council of Teachers of Mathematics, 1987

Each phase of problem solving can be probed in order as the student works through the problem, investigation, issue, or assignment. The information gained can be used to help the teacher and student determine where the block is and what remedial action is appropriate.

USE OF SELF-ASSESSMENT DATA FROM STUDENTS

Students can provide self-assessment data which can be useful to themselves and to the teacher. The usefulness of such assessments depends on how candidly they report their feelings, beliefs, intentions and thinking patterns. Such information plays a role in fully evaluating progress toward the learner expectations of the program, particularly the attitude and skill components.

Student Reports

This method requires the student's written or oral report on a problem–solving experience. Students are asked to think back and describe how they worked through a particular investigation or problem–solving assignment of any type. Focus questions for the student report are useful in helping the student formulate the report. A sample of focus questions follows:

Student Report: Focus Questions

Use the following questions to help you look back and describe your thinking as you worked toward a solution to the problem (or worked through the investigation, assignment, project).

1. What did you do when you first saw the problem? What were your thoughts?
2. Did you use any problem–solving strategies (like following science inquiry steps, research method, SQ3R, identification of perspectives)? Which ones? How did they work?
3. Did you try one approach that didn't work and have to stop and try another approach? How did you feel about this?
4. Did you complete the assignment? (investigation, project) How do you feel about this?
5. Did you check your work in any way to assure the original assignment was carried out correctly? Did you feel sure it was correct? (satisfactory)

The focus questions above are only a sample. You may wish to limit the questions to one phase of the problem–solving process, asking questions about that one phase alone. Decide what aspect you want the students to report on and formulate questions that stimulate their recollections of experiences during that phase.

Adapted from *How to Evaluate Progress in Problem Solving*, National Council of Teachers of Mathematics, 1987

Inventories

An inventory is a list of items the student selectively chooses to give an organized self-appraisal of performance or attitudes. Inventories have the advantage of allowing students input into the evaluation process while requiring very little of the teacher's time for collection of evaluation data, once an efficient instrument is developed. The accuracy depends on the quality of insight the student has into his or her performance or attitude. Such inventories can be misinterpreted or the student may not be candid. It is easy to assume unwarranted reliability. Thus, it is recommended that inventories be used only in conjunction with other evaluation techniques such as teacher observations and tests.

Attitude Inventories

The most common form of inventory is an attitude inventory. A sample of an attitude toward science inventory, developed for Alberta Education in 1978, has been included with details for administration and scoring. It is meant to be administered before the course begins and after the course is completed. Such a survey is not meant to determine individual attitudes but to look at the class results as a whole to determine if significant different in attitudes has occurred during the course duration. A form for recording scores on these inventories has also been provided (page 143).

Modified attitude inventories, where students are encouraged to write freely about their feelings toward various activities within a particular unit, can be drawn up and administered at the end of each unit. Samples for the "Body Systems" and "Household Science" units of Science 14 and the "Safe Transportation" unit of Science 24 have been included on pages 145–147. These instruments can start off assessing students attitudes but gradually work into encouraging discussion of some major concepts within those units, requiring application of some specific skills. The "Body System" survey is of this type.

Personal Performance Inventory

Having the students rate their performance in class on a regular basis can be helpful. It can serve to focus their attention on desired behaviours through a process of self-assessment. The teacher can compare the student self-assessment with their rating of student performance in any given period. An example of a simple inventory follows:

Science 14 Personal Performance Inventory

Instructions: Check the box if "yes"; leave blank if "no."

______1. Arrived on time with required supplies
______2. Copied any required notes and filled handouts in appropriate section of notebook
______3. Listened attentively to instructions for the daily activity, asking for clarification if not understood
______4. Became involved in class discussion by actively participating and/or following the discussion closely
______5. Got to work on the activity quickly and stayed with it until completed
______6. Worked cooperatively with other group member(s) and contributed my share of effort in completing the activity
______7. Completed all assigned questions in class
______8. When finished the assigned activity an enrichment activity was chosen and worked on for remaining time

Further examples of self-assessment instruments of various types may be found on pages 148–150.

HOLISTIC SCORING

Holistic scoring is a quick and efficient method of subjectively evaluating students' problem–solving skills, participation, or the products associated with various activities and assignments. Different types of holistic scoring are possible: some with several categories of criteria for awarding marks, others short and simple. The more specific the criteria, the more objective this type of subjective scoring can become. The type of holistic scoring used depends on the purpose of your evaluation.

All–or–None Scoring

All–or–none scoring can be useful when evaluating a student effort as acceptable or not acceptable, allocating a small number of marks if acceptable and none if not. This type of scoring is efficient for quickly checking if assignments are done, problems are attempted, or other tasks are completed. Students receive marks for effort which encourages participation. All–or–none scoring should be limited to a small proportion of the course's total mark allocation, perhaps less than five percent.

Focused Holistic Scoring

Focused Holistic Scoring is useful for evaluation of problem–solving ability or participation. A problem–solving model, in the broad sense, can be applied to scientific inquiry, decision–making or any other activity or assignment a student may be required to do.

The products of such activities may be laboratory reports, perspective identification exercises, questions assigned on daily activities, oral presentations, models, paragraphs, essays, library research papers, collages, scrapbooks, or a video production. All these items, as well as written response questions on formal tests, may be evaluated using Focused Holistic Scoring.

This method involves the establishing of categories on a scoring scale; in the example below a 5–4–3–2 scale was chosen, with 0 for not done or handed in, and E for an excused student. Using an even number of scoring categories can be useful (but not essential) as it helps prevent the tendency to assign marks to the middle category of the scale. In the example on page 129 a holistic scoring instrument demonstrates how three different aspects of a laboratory investigation could be holistically scored; the problem–solving skills exhibited, student participation and the product, in this case a laboratory report.

SAMPLE EVALUATION MATRIX: FOCUSED HOLISTIC SCORING

Activity / Score	Problem-Solving Skills	Participation	Product (e.g. Laboratory Report, Perspective Identification, Scrapbook)
5	Understands problem (investigation, issue, assignment) Selects necessary strategies Solves correctly (completes) Evaluates appropriateness of solution (conclusion, opinion, product)	Gets involved quickly Stays involved	Complete, Correct, Commands respect, neatly done
4	As above but fails to evaluate solution (conclusion, opinion, product)	Needs a start Stays involved	Mostly complete Correct, neat Good work
3	Errors evident but strategies selected led to a solution (conclusion, opinion product)	Needs periodic reminding to stay on task	Somewhat complete Minor errors Satisfactory
2	Errors evident No solution provided (no conclusion, opinion, product)	Needs constant reminding to stay on task	Incomplete Major errors. Untidy
E	Acceptably Excused From The Assignment		
0	Not Done Or Handed In		

On page 151 a simple background to problem solving in the laboratory is presented. It is followed by samples of focused holistic scoring in the following areas:

- Problem-solving strategies in experimental design assignment
- Communication Skills in experimental design assignment
- Test Question – Experimental Design

Library Research Assignment:
  - Evaluating how Science and Technology are handled
  - Evaluating Communication Skills – oral or written
- Test Question – Science and Technology
- Variety of Holistic scoring instruments for communication skills

Analytic Scoring

Analytic scoring assigns point values (scores) to each of several phases of the problem-solving process. First an analytic scale is developed to identify those phases of the problem-solving process that you wish to evaluate. Next a range of possible scores for each phases is drawn up. The suggested range is 0–2.

An analytic scoring scale appears below. It was designed for three phases or categories of problem-solving. In each category a certain number of points would be assigned. Specific criteria for awarding points in each category are necessary.

Analytic Scoring Scale	
Understanding the Problem	0: Complete misunderstanding of the problem 1: Part of the problem misunderstood or misinterpreted 2: Complete understanding of the problem
Planning	0: No attempt, or totally inappropriate plan 1: Partially correct plan based on part of the problem being interpreted correctly 2: Plan could have led to correct solution if implemented properly
Follow Through	0: No conclusion/product, major faults in original plan, failure to revise and carry through 1: Minor errors in data/information organization and analysis, minor shortcomings in conclusion/product 2: Collected and analyzed data/information with efficiency and accuracy producing reasonable conclusion/product

This type of scoring could be applied to a large variety of written assignments such as laboratory reports, paragraphs, essays, short-answer questions, analysis of newspaper articles, or identification of perspectives on an issue. The sample scoring method above is based on the belief that problem-solving evaluation should involve more than checking the final answer, conclusion, decision, or product. It enables the teacher to assess students' performance in relation to predetermined steps of the problem-solving process.

Analytic scales are useful when:

- it is desirable to give students feedback on their performance in key categories associated with problem-solving.
- it is desirable to give students feedback on their performance in key categories associated with problem-solving.
- it would be useful to have specific information about students' strengths and weaknesses
- the teacher is trying to identify specific aspects of problem-solving that may require extra instruction
- the teacher has enough time to carefully analyze each student's written work.

In some cases a student's written work may not provide enough information regarding their thinking processes and assigning points in one or more categories becomes difficult. Further oral questioning encouragement toward more complete reporting would be in order. The categories which make up the scale should receive direction attention during instruction, serving as a framework for students. The scales should be carefully correlated to the instructional program. Comparisons of students' scores should be made carefully, with the realization that two students with the same overall scores may have performed quite differently. For example, a student scoring 2–1–1 has performed quite differently from a student scoring 2–2–0. Samples of analytic scoring scales for written and oral projects can be found on pages 153–157.

Adapted from *How to Evaluate Progress in Problem Solving*, National Council of Teachers of Mathematics, 1987

OBJECTIVE EVALUATION

Objective evaluation items are easily scored. They are either right or wrong, with little or no element of subjectivity to contend with. Such items, although easily marked, require careful construction. Common forms of objective evaluation include:

- multiple choice
- true–false
- matching
- completion
- sequencing problems
- measuring problems
- definition of terms
- diagrams and labels

Development of Objective Items

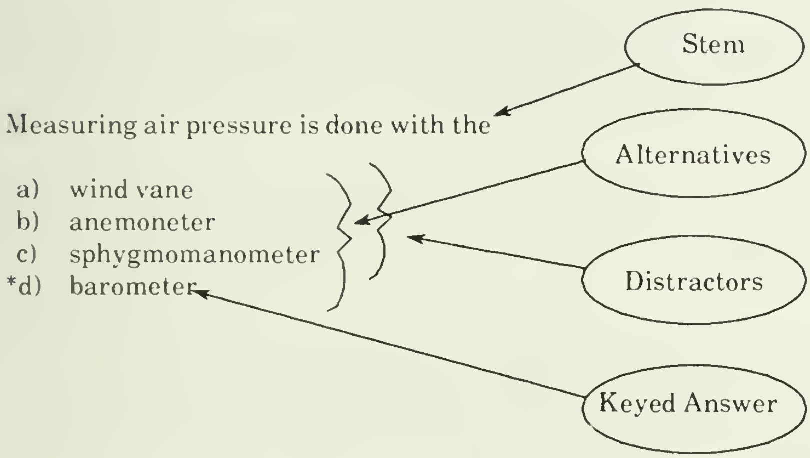
When developing objective evaluation items the following guidelines should apply:

- test achievement of the General or Specific Learning Expectations from the Program of Studies
- be free from bias (for example, gender, race, religion, culture)
- reflect an appropriate level of difficulty
- clearly state the task to be completed through the use of appropriate instruction words

Multiple Choice Items (by Cam McTavish)

Multiple choice items can measure the knowledge, understanding, judgment, or problem–solving ability of students. They pose a task with a solution that is predetermined by the item writer. The student is provided with alternative answers, only one of which is correct or best.

The following diagram identifies and explains the terms used to define the parts of a multiple choice item.



Multiple–choice items courtesy of Cam McTavish
Hillside Jr/Sr High School, Valleyview, Alberta

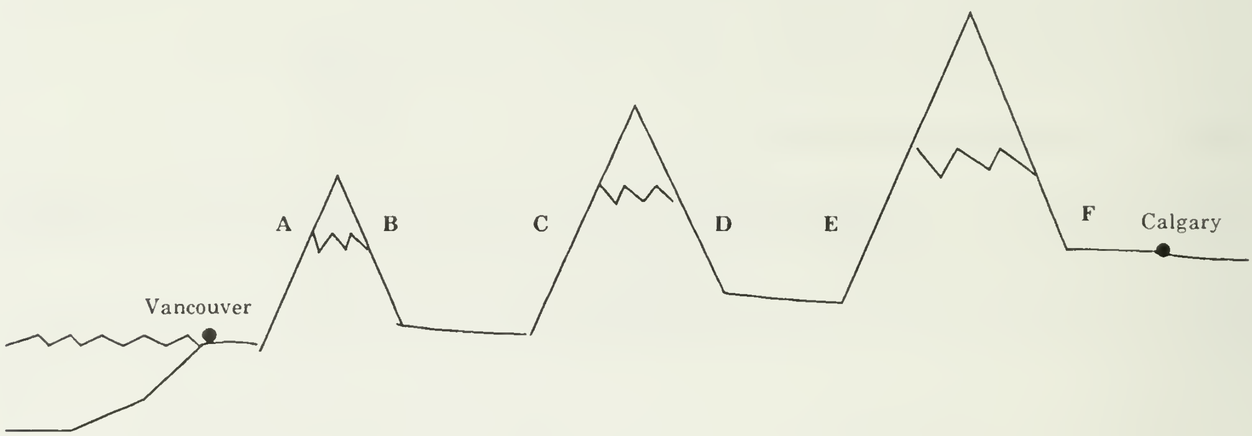
There are two types of multiple–choice items:

The *discrete item* stands on its own without any additional information or directions. It may take the form of a question or an incomplete statement. One example was given above, and a second follows.

The most dense air is
 a) in warm fronts
 b) warm air
*c) cold air
 d) in upward convection cells

The *passage–or context–dependent item* provides information separate from the question stem. Thus, the stem has meaning only in relation to the passage or information provided. An example follows below:

Use the diagram below of mountain ranges between Vancouver and Calgary to answer questions 1–3.



1. Most rainfall occurs near letter
   *a) A
   b) B
   c) C
   d) D

2. A rainshadow would be found near letter
   a) A
   b) C
   c) E
   *d) F

3. The Rockies are found between letters
   a) A and B
   b) C and D
   *c) E and F
   d) they are not on this diagram

A major advantage of multiple–choice items is that a substantial amount of course material can be sampled in a relatively short period of time, particularly for material involving simple recall or comprehension.

Multiple–choice items courtesy of Cam McTavish
Hillside Jr/Sr High School, Valleyview, Alberta

The disadvantages of this type of evaluation include:

- items are not well adapted to measuring the capacity to organize material and to demonstrate knowledge in depth
- items requiring thoughtful response can be constructed, but are time consuming to construct
- items cannot eliminate the efforts of guessing

Construction Guidelines

- The item should focus on a single problem. The solution method can be either single-step or multi-step, but only one question should be asked.
- The stem of a correct-answer question should be self-contained if at all possible. The examinees should be able to read the stem (and passage if appropriate) and answer the question without reference to the alternatives.
- Unnecessary wording and details should be eliminated from the stem and alternatives.
- The item must reflect a specific curricular objective.
- The stem should be grammatically correct within itself and in its relationship to each alternative.
- The stem should not provide grammatical clues to any alternative.
- The sentence structure and vocabulary should not present any unnecessary challenge to comprehension.
- Negatively worded stems should be avoided if possible. If they are used, the negative wording should be stressed, using upper case.
- Phrases such as "of the following" should not be used in the stem of a correct-answer item. They may be used in a best-answer question.
- Words common to all alternatives should be placed in the stem.
- The phrasing of each of the alternatives should be similar to that of the stem in style and complexity.
- Key words from the stem should not be repeated in an alternative.
- Key words from a reading passage or data set should not be repeated in the stem or in an alternative.
- All distractors should be plausible. The best distractors reflect common misconceptions or common mistakes.
- Absolute terms such as "always" or "never" should be avoided if possible.
- Alternatives such as "none of the above" or "all of the above" are unacceptable.

True-False

These items consist of declarative statements for which there are only two possible alternatives. Each statement is either true or false.

Construction Guidelines

- Provide a space to the left of the statement for writing the chosen response.
- Avoid broad general statements since they are to be judged true or false.
- Avoid words such as as usually, generally, often and sometimes, which are periodically seen in true statements, and terms such as always, never, all, none, and only, which may appear in false statements.
- Avoid trivial statements which have very little to do with the learning objective.
- Avoid long and complex statements which obscure the main idea.
- Attribute opinion statements to a source in order to clarify whose opinion is being evaluated.
- Use approximately the same number of true and false statements.
- Vary the order of true and false statements; do not set patterns.

Adapted from *An Introduction to Item Writing*,
Student Evaluation and Records Branch
Alberta Education, May 1989

Completion Items

These items require students to fill in blanks to complete statements.

Construction Guidelines

- Ensure that each item has only one correct answer.
- Include adequate basic information directing students to the exact term required.
- Eliminate extraneous information
- Only have one blank per item.
- Avoid grammatical clues such as using the term "an" prior to the blank.
- Try to design items that go beyond mere knowledge of terminology.

Matching Items

These items consist of two parallel columns with each item in the first column to be matched with the correctly corresponding item in the second column.

Construction Guidelines

- The association between the two columns is based upon the same concept.
- All items in the first column must relate to each other or be based upon the same concept.
- Items posing a question statement should be in the left column while response words or phrases, should be in the right column.
- Include more items in the right column than in the left column.
- Place all parts of the item on the same page.
- Use a manageable number of items, usually from 5 to 12.

STUDENT PORTFOLIOS

A technique which can encourage students to keep trying their best, even if they have recieved a low mark or two during the course, is the keeping of a portfolio. In the portfolio students keep all marked assignments, tests, quizzes or projects. Choice is then allowed. Students are free to choose a set number of assignments, projects, quizzes and tests to count in their final evaluation.

As an example:

6 of 8 assignments
3 of 4 major unit projects
3 of 4 unit quizzes
4 of 5 unit tests

The student can be asked to submit the portfolio with the selected items and provide explanation as to why specific items were chosen to be counted. Ask them to present their decision and to rank their reasons for selection of those items. This information is useful to teachers in determining final evaluations.

Discussions with students on a one-to-one basis regarding their portfolios can be a very insightful evaluation technique.

SCHOOL SUBJECTS ATTITUDE SCALES GENERAL INFORMATION

A Brief Description of the School Subjects Attitude Scales

Intended for Educators Considering Use of This Instrument

PLANNING SERVICES

ALBERTA EDUCATION

July, 1983

GENERAL INFORMATION

SCHOOL SUBJECTS ATTITUDE SCALES

Description of the Scales:

The School Subjects Attitude Scales was developed during 1978 and 1979 by V.R. Nyberg and S.C.T. Clarke of the University of Alberta. The project was recommended by the Minister's Advisory Committee on School Achievement and was funded by Planning and Research, Alberta Education.

Attitudes are closely associated with feelings and emotions. They influence how a person will react to a certain stimulus such as an idea, object or person. Students' attitudes toward school subjects probably have an effect on motivation, and where choice is possible, on courses and programs taken.

The purpose in developing the scales was to make available an instrument for measuring students' attitudes toward school subjects. It was recognized that a number of goals of education involve the affective domain. While affective goals are important aspects of schooling no commercially prepared instruments for measuring students' attitudes toward school subjects were available. It was therefore decided that the feasibility of developing an instrument be explored.

The scales were developed as group (classroom) measures of students' attitudes toward school subjects. They were not intended for use with individuals.

A liste of more than 100 bipolar adjectives was first assembled from various sources, including other semantic differential instruments. Through discussions with teachers and pupils, and through analysis of trial forms, twenty-four word pairs were selected. Factor analysis revealed three scales: evaluation, usefulness, and difficulty. Either bipolar pairs were adopted for each scale.

Five spaces between each pair are available for the student to rate the school subject. These spaces are labelled, very much, a bit, neither, a bit and very much. As in all semantic differential type scales, the concept to be judged, in this case the school subject, is rated by placing marks between the adjective pairs. In this way the student expresses what he or she thinks and feels about the school subject.

The scales were designed to be readily understood by teachers and students, to minimize faking, to yield more than one score, to produce valid and reliable results, to be short enough so that several subjects could be rated in a normal class period, to be suitable for all school subjects at widely different grade levels, and to be amendable to both hand and machine scoring. They were intended for use in Grade 1 to Grade 12, but it is likely that they could be used in post secondary institutions.

One possible use of the scales is program evaluation. Thus, if a change in program is proposed, student attitude prior to the change, soon after the change is implemented, and later, could be obtained. The use of the scales in curriculum development is obvious. In addition, differences in attitudes related to class size, socio economic status of parents, geographic area (e.g., urban-rural), and ability level could be explored.

One of the common features of attitude measurement is that the person involved usually detects the purpose and may give false responses. This "faking" usually involves giving responses which are thought to be socially acceptable. For example, if a student thinks the teacher of a subject will be able to identify his or her responses, the student may indicate that the subject is interesting, is useful, etc., to a greater extent than would be the case if anonymity were assured. If the measurement is to reflect the students' true attitudes, procedures must be adopted to minimize the motivation for faking.

Directions for Administering the Scales:

Directions to the student are available with the scales and are not reproduced here. It is necessary that HB pencils be used if answer sheets are to be machined scored. Sufficient of these for the largest class will facilitate administration of the scale.

Because faking is possible, procedures should be adopted to reduce motivation for faking. These include the following: student anonymity (the student's name is not required on the answer sheet), no monitoring of responses by the teacher of the student in the subject being rated, and general explanations of the group nature of the results.

The person who administers the scale should be, to the student who is rating a subject, neutral with respect to the subject; e.g., a non-teaching principal or vice-principal, teacher of another subject, school psychologist, or the like. Monitoring should be restricted to insuring that the rating is being done correctly. Names or other identifying data should not be prescribed for the response sheets. The person who collects the sheets should collect them face down, to avoid appearing to scrutinize responses. These suggestions for administration are all designed to reduce faking.

Students have seldom had experience with ratings. The first time the scales are administered to a class the directions to the student should be read with the students, and illustrated. Then the person administering the instrument should start the students on the scales with the "nice-awful" bipolar pair and illustrate how the rating of this pair should be made. The administrator should then indicate that the rest of the bipolar pairs are completed for the same subject in the same way.

Depending on the time required for students to grasp the task, the first administration of the scale may take ten to twenty minutes. Once having had experience, students can usually rate a school subject in five minutes.

Because attitudes towards school subjects may be coloured by general attitudes (feeling tired or bored) for comparative uses it is suggested that the scale be administered during the second period of the school day.

Scoring:

Each response has a possible value ranging from 1, representing the most negative attitude, to 5, representing the most positive feeling. The items and score values for each response position are shown on the next page. Since each of the three scales, evaluation, usefulness and difficulty, contains five adjective pairs, the score range for each scale is 8 to 40. A score of 24 on a scale represents a completely neutral score. Any score above 24 represents a completely neutral score. Any score above 24 indicates a general positive feeling toward a subject, and similarly, any score below 24 represents a negative feeling. It will e observed that a positive attitude on the evaluative scale (nice, interesting, pleasant, like, bright, alive, lively, exciting) was signified by a positive score. Usefulness (useful, important, practical, valuable, helpful, necessary, advantageous, meaningful) was signified by a positive score. Difficulty (hard, heavy, confusing, complicated, advanced, strange, puzzling, rigorous) was associated with a negative score; that is, the higher the score the easier the student found the subject to be. This is consistent with the decision to make higher scores associated with favourable attitudes.

SCORING GUIDE

Evaluative

nice	5	4	3	2	1	awful
boring	1	2	3	4	5	interesting
unpleasant	1	2	3	4	5	pleasant
dislike	1	2	3	4	5	like
bright	5	4	3	2	1	dull
dead	1	2	3	4	5	alive
lively	5	4	3	2	1	listless (inactive, lazy)
exciting	5	4	3	2	1	tiresome (makes a person feel tired)

Usefulness

useless	1	4	3	4	5	useful
important	5	4	3	2	1	unimportant
impractical	1	2	3	4	5	practical
worthless	1	2	3	4	5	valuable
helpful	5	4	3	2	1	unhelpful
unnecessary	1	2	3	4	5	necessary
harmful	1	2	3	4	5	advantageous (brings good or gain)
meaningful	5	4	3	2	1	meaningless (doesn't make sense)

Difficulty

hard	1	2	3	4	5	easy
light	5	4	3	2	1	heavy (a lot of work)
clear	5	4	3	2	1	confusing (mixes a person up)
complicated	1	2	3	4	5	simple
elementary	5	4	3	2	1	advanced (beyond the beginning level)
strange	1	2	3	4	5	familiar
understanding	5	4	3	2	1	puzzling (hard to understand)
undemanding	5	4	3	2	1	rigorous (has to be exactly right)

Reliability and Validity:

The reliability of the scales various from scale to scale, subject to subject, and grade to grade. When used for classroom groups the reliabilities are very nearly all well above 90. Calculations of a sample of the reliability estimates indicates that the Difficulty scale is slight less reliable than the other scales.

On four different comparisons the scales were found to be valid. The comparisons included expert opinion, student preferences, sex differences, and cultural differences. A study of the relationship with achievement and intelligence gave further evidence of validity, as did the factor analyses.

Interpretation of Results:

Scores can also be interpreted in an absolute sense. Each scale consists of eight word pairs, therefore, the score range for each scale is 8 to 40. A "neutral" attitude corresponds to a score of 24. An evaluative socre above 24 indicates that the subject is liked, a usefulness score above 24 indicates that the students find the subject <u>useful</u>, and difficulty score above 24 indicates that the students find the subject <u>easy</u>. Similarly, scale scores below 24 indicates a dislike for the subject, that it is not useful, and that is is difficult.

Alberta
EDUCATION

SUBJECT	

SCHOOL	

Place only one mark between each pair of words.
Complete ALL of the pairs.

Sex Female ☐ Male ☐

	very much	a bit	neither	a bit	very much	
nice	☐	☐	☐	☐	☐	awful
boring	☐	☐	☐	☐	☐	interesting
unpleasant	☐	☐	☐	☐	☐	pleasant
dislike	☐	☐	☐	☐	☐	like
bright	☐	☐	☐	☐	☐	dull
dead	☐	☐	☐	☐	☐	alive
lively	☐	☐	☐	☐	☐	listless (inactive, lazy)
exciting	☐	☐	☐	☐	☐	tiresome (makes a person feel tired)
useless	☐	☐	☐	☐	☐	useful
important	☐	☐	☐	☐	☐	unimportant
impractical	☐	☐	☐	☐	☐	practical
worthless	☐	☐	☐	☐	☐	valuable
helpful	☐	☐	☐	☐	☐	unhelpful
unnecessary	☐	☐	☐	☐	☐	necessary
harmful	☐	☐	☐	☐	☐	advantageous (brings good or gain)
meaningful	☐	☐	☐	☐	☐	meaningless (doesn't make sense)
hard	☐	☐	☐	☐	☐	easy
light	☐	☐	☐	☐	☐	heavy (a lot of work)
clear	☐	☐	☐	☐	☐	confusing (mixes a person up)
complicated	☐	☐	☐	☐	☐	simple
elementary	☐	☐	☐	☐	☐	advanced (beyond the beginning level)
strange	☐	☐	☐	☐	☐	familiar
understanding	☐	☐	☐	☐	☐	puzzling (hard to understand)
undemanding	☐	☐	☐	☐	☐	rigorous (has to be exactly right)

Science Attitude Survey Synopsis

School: ____________________

Teacher: ____________________

Pupil	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Averages
Evaluative																					
Usefulness																					
Difficulty																					

Pupil	21	22	23	24	25																Averages
Evaluative																					
Usefulness																					
Difficulty																					

Class Average Results

Evaluative	=
Usefulness	=
Difficulty	=

SCIENCE 14
UNIT I – BODY SYSTEMS

Name: ______(optional)________

1. Please rate the Unit Body Systems by circling the number that reflects your feelings. Remember that the #3 means undecided and #1 and #5 represent a strong feeling for the word is closest to that number. The number 2 and 4 mean somewhat – again, refer to the word closest to #2 or #4. If you don't remember what topics were covered, refer to the next page before you circle these numbers.

boring	1	2	3	4	5	interesting
dislike	1	2	3	4	5	like
useless	1	2	3	4	5	useful
important	1	2	3	4	5	unimportant
impractical	1	2	3	4	5	practical
I will never use this information	1	2	3	4	5	I will never use this information
worthless	1	2	3	4	5	valuable
meaningless	1	2	3	4	5	meaningful
hard	1	2	3	4	5	easy
light workload	1	2	3	4	5	heavy workload
clear	1	2	3	4	5	confusing
too complicated	1	2	3	4	5	too simple
understandable	1	2	3	4	5	hard to understand

2. The activities that I liked best in this unit were ...
3. The activities that I like least in this unit were ...
4. The information in this unit which I found most useful to me was ...
5. Suggestions that I have for improving this unit are ...
6. Please make comments concerning the presentation from Mrs. MacLeod, the public health nurse.
7. Please comment concerning the field trip to the physiotherapy clinic.
8. If you felt the activity or information was useful write yes. If you felt the activity or information was not useful write no.

_____a) cell model and cell parts
_____b) cells, tissues, organs, systems
_____c) identifying the bones of the skeletal system
_____d) differences between male and female skeletons
_____e) x-ray bone identification
_____f) types of broken bones
_____g) first aid (splinting, sprains)
_____h) using the microscope
_____j) making your own skeleton
_____k) male and female reproductive systems
_____l) fertilization
_____m) fetal development
_____n) "Miracle of Life" video
_____o) heredity
_____p) determining sex of child
_____q) lung volume lab
_____r) pulse lab

9. During this unit we have emphasized that one body system affects another body system. Using your own example, provide detailed information on one body system. Include the major organs of that system and their functions. Then, assuming failure of that system, explain how another body system may be affected by this failure.

10. Science has contributed to the development of techniques and devices for improving the human body condition. Choose two body systems and for each system give two examples of how science has given us a better technique or device "for assisting" that system when it is failing to perform its function normally. (Two systems – two examples with discussion for each system).

Courtesy of Georgina Lester,
Parkland Composite High School, Edson, Alberta

SCIENCE 14
UNIT II – HOUSEHOLD SCIENCE

Name: ______(optional)______

1. Please rate Unit II Household Science by circling the number that reflects your feelings. Remember that the #3 means undecided and #1 and #5 represent a strong feeling for the word that is closest to that number. The number 2 and 4 mean somewhat – again, refer to the word closest to #2 or #4. If you don't remember what topics were covered, refer to the next page before you circle these numbers.

boring	1	2	3	4	5	interesting
dislike	1	2	3	4	5	like
useless	1	2	3	4	5	useful
important	1	2	3	4	5	unimportant
impractical	1	2	3	4	5	practical
I will never use this information	1	2	3	4	5	I will never use this information
worthless	1	2	3	4	5	valuable
meaningless	1	2	3	4	5	meaningful
hard	1	2	3	4	5	easy
light workload	1	2	3	4	5	heavy workload
clear	1	2	3	4	5	confusing
too complicated	1	2	3	4	5	too simple
understandable	1	2	3	4	5	hard to understand

2. The activities that I liked best in this unit were . . . Why?
3. The activities that I like least in this unit were . . . Why?
4. The information in this unit which I found most useful to me was . . .
5. Suggestions that I have for improving this unit are . . .
6. Make comments on the following sections of this unit on the line provided, using the back of the sheet if extra room is needed. Consider the usefulness of the activity and how you felt about doing it, when commenting (two full lines for comment should be provided for each item).

a) Comparing ancient and modern measurement methods (e.g., cubits and spans versus meters)
b) Measurement lab (volume, weight, distance)
c) Measurement of temperature lab (boiling H_2O)
d) Measurement of temperature graph (plotting 2 weeks)
e) Posters classifying household chores, and the products that are used in each
f) Sorting products into solutions and suspensions
g) Making solutions and suspensions lab
h) Filtering solutions and suspensions lab
i) What substances mix with water lab (oil, vinegar, alcohol, paint thinner)
j) Emulsifiers lab (baking soda, soap)
k) Making a saturated solution (room temperature H_2O.
l) Making a supersaturated solution (heating the H_2O)
m) testing for acids and bases (indicators)
n) Testing for pH levels lab
o) Household safety and first aid situations
p) Botulism and microorganisms lab
q) Comparing radiation, convection, conduction

Courtesy of Georgina Lester,
Parkland Composite High School, Edson, Alberta

SAMPLE UNIT ATTITUDE SURVEY
(leading into skill and concept assessment question 8)

SCIENCE 24
UNIT IV – ARRIVE ALIVE

Name: ______(optional)______

1. Please rate Unit IV Arrive Alive by circling the number that reflects your feelings. Remember that the #3 means undecided and #1 and #5 represent a strong feeling for the word that is closest to that number. The number 2 and 4 mean somewhat – again, refer to the word closest to #2 or #4. If you don't remember what topics were covered, refer to the next page before you circle these numbers.

boring	1	2	3	4	5	interesting
dislike	1	2	3	4	5	like
useless	1	2	3	4	5	useful
important	1	2	3	4	5	unimportant
impractical	1	2	3	4	5	practical
I will never use this information	1	2	3	4	5	I will never use this information
worthless	1	2	3	4	5	valuable
meaningless	1	2	3	4	5	meaningful
hard	1	2	3	4	5	easy
light workload	1	2	3	4	5	heavy workload
clear	1	2	3	4	5	confusing
too complicated	1	2	3	4	5	too simple
understandable	1	2	3	4	5	hard to understand

2. The activities (experiments) that I like best in this unit were . . .
3. The activities (experiments) that I liked least in this unit were . . .
4. The information I found most useful to me from this unit was . . .
5. Suggestions that I have for improving this unit are . . .
6. Please make comments concerning the teacher's style of teaching (pluses, minuses, suggestions)
7. Was the talk by the local police department useful to you? Why or why not?
8. Describe how science and technology can be used to meet the demands of society with respect to transportation safety.
9. Has this unit changed your attitude towards seat belts and/or drinking and then driving? Explain why or why not.
10. Please write yes if you feel the information given in class was useful, no if you feel it was not.

_______a. the second collision
_______b. Newton's laws of motion
_______c. model of passenger without a seat belt
_______d. Newton's second law of motion
_______e. eggs and brains
_______f. how a seat belt works
_______g. testing safety technology
_______h. seat belts – verdict please
_______i. conservation of energy in crashes
_______j. calculating collision momentum
_______k. wheels, human error and alcohol
_______l. society, technology and transportation concerns
_______m. building safer highways.

LISTENING SELF-EVALUATION CHECKLIST: GENERAL

Name____________________________ Date____________________________

1.	I listen carefully when my teacher gives instructions.	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
2.	I sit where I can see and hear.	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
3.	I start thinking about other things and lose track.	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
4.	I try to ignore distractions around me.	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
5.	I'm often too tired to pay close attention.	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
6.	It is often too hot or too cold in the room.	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
7.	I pay attention because I need to pass the course.	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
8.	I talk to my friends instead of listening to the teacher.	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
9.	The classroom is too noisy.	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
10.	I'm too worried about other problems to pay attention in class.	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER

LISTENING SELF-EVALUATION CHECKLIST: SPECIFIC

1.	Do I sit where I can hear the teacher?	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
2.	Do I dress appropriately so that the room temperature is comfortable?	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
3.	Do I talk and listen to my friends instead of paying attention to the teacher?	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
4.	Do I ask questions when I do not understand?	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
5.	Do I "turn off" my listening if the ideas seem difficult?	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
6.	Do I daydream a lot in class?	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
7.	Am I too tired to pay attention?	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
8.	Does it matter if it is the first or last block of the day?	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
9.	Is there a lot of outside noise?	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER
10.	Do I blame the teacher instead of trying to solve the problem?	ALWAYS	USUALLY	SOMETIMES	HARDLY EVER

Enhancing and Evaluating Oral Communication in Secondary Grades, Ministry of Education, Province of B.C., 1988

SELF-RATING SCALE FOR ORAL PRESENTATIONS

Directions: Indicate how satisfied you feel about the following features of your topic, preparation and presentation by checking the appropriate line.

	NOT AT ALL	A LITTLE	QUITE	VERY	EXTREMELY
TOPIC.					
Interesting to me	____	____	____	____	____
Interesting to audience	____	____	____	____	____
Appropriate for assignment	____	____	____	____	____
PREPARATION. I was able to:					
Find sufficient information	____	____	____	____	____
Select the information that was appropriate for my speech	____	____	____	____	____
Organize my ideas so the audience could follow easily	____	____	____	____	____
Develop an effective opening	____	____	____	____	____
Develop an effective closing	____	____	____	____	____
Prepare useful note cards	____	____	____	____	____
Practise until I was confident about my presentation	____	____	____	____	____
PREPARATION. I was able to:					
Feel confident and poised	____	____	____	____	____
Speak clearly	____	____	____	____	____
Speak with expression	____	____	____	____	____
Speak fluently with few pauses or hesitations	____	____	____	____	____
Make contact with the audience	____	____	____	____	____
Use my notes effectively	____	____	____	____	____
Follow the plans I had made	____	____	____	____	____

RATING SCALE: PARTICIPATION IN CLASSROOM ORAL ACTIVITIES

NAME______________________ DATE__________to__________

INSTRUCTIONS: Use the following scale to rate each aspect of classroom behaviour. Space is provided at the bottom for a summary comment and an overall score or rating if one is desired. Note that the overall rating need not be the "average" of the individual items – some items may be more important than others and thus should be weighed more heavily in determining the overall score.

Rating Criteria:

1 Never. May be obstructive or uncooperative.
2 Rarely. Usually needs prompting.
3 Occasionally. Varies by activity or topic.
4 Frequently. Observed in a variety of activities.
5 Characteristic of this student. A definite strength.

1.	Answers questions in class.	1	2	3	4	5
2.	Volunteers observations or ideas.	1	2	3	4	5
3.	Asks questions for clarification.	1	2	3	4	5
4.	Asks questions or offers observations which prompt or extend class discussion.	1	2	3	4	5
5.	Follows oral instructions accurately.	1	2	3	4	5
6.	Supports and encourages other students.	1	2	3	4	5
7.	Listens attentively and courteously to the teacher.	1	2	3	4	5
8.	Listens attentively and courteously to other students.	1	2	3	4	5

Summary Comments and Score

GROUP SELF-RATING SCALE

NAME______________________________ DATE______________________________

		NOT AT ALL	SOMEWHAT	EXTREMELY
1.	How clear were you about your role in this group?	☐	☐	☐
2.	How well were you able to focus your attention on the task?	☐	☐	☐
3.	How completely did you share your ideas?	☐	☐	☐
4.	How much effort did you put into trying to influence decisions?	☐	☐	☐
5.	How effective were you in influencing decisions?	☐	☐	☐
6.	How well did you listen to others?	☐	☐	☐
7.	How sensitive and supportive were you to others' feelings and ideas?	☐	☐	☐
8.	Overall, how satisfied were you with your contribution to this activity?	☐	☐	☐

Look back over your ratings on this sheet and place check marks beside two areas in which you could improve. In the space below, set targets or reminders which could help you to improve.

GROUP SELF-RATING SCALE

Place an X on each scale to indicate how this group would be rated for the task just completed.

Clear task and sequence of activities	____	____	____	____	Confused. No idea of what to do
Extremely trusting and open with each other	____	____	____	____	No trust. A closed group
Extremely sensitive and supportive to each other	____	____	____	____	No awareness or concern for others
All members took part effectively	____	____	____	____	Only one or two contributed
Disagreements welcomed and explored	____	____	____	____	Disagreements avoided or repressed
Decisions made by consensus	____	____	____	____	No decisions reached at all
Leadership strong, flexible and shared	____	____	____	____	No leadership – drifted

SCIENCE INQUIRY APPLICATION

Laboratory Activities: Problem-Solving in the Laboratory

The generic problem-solving model is the basis of the scientific method. Experimental design incorporates the planning, data collection/analysis and evaluation/explanation stages common to problem-solving models. Different laboratory activities may be designed to focus and elaborate on different components of the model, but such components cannot be held in isolation if they are to have any meaning.

One model for the steps involved in problem-solving as applied to scientific investigations follows:

Planning

Designing experimental procedures, noting patterns and discrepant events in an attempt to seek information, generating hypotheses or theories and organizing precise questions directed towards achieving results.

Collecting Data

Selecting the appropriate variables to observe and quantify while identifying the instruments and materials to be used, keeping in mind estimates, significance and appropriate models that exist or can be created to assist in drawing conclusion.

Analysing Data

Predicting or inferring through the use of graphing, tabulating, correlating or classifying of information in order to arrive at a consensus that supports or rejects a theory, prediction, model or hypothesis.

Explaining

Describing, defining, synthesizing, interpreting and communicating of information for the creating or refining of models, prediction, hypotheses and theories. Discussion for refinement of experimental design and suggested means of obtaining more precise and pertinent data is a desirable outcome of this activity.

EXPERIMENTAL DESIGN EVALUATION

PROBLEM-SOLVING STRATEGIES

The student has displayed an understanding of the problem, the conditions of the problem, selects the necessary data and strategies to solve the problem and evaluates the appropriateness of their solution.

5 The design is clearly laid out with each stage identified, appropriate materials and method are used, with data collected and interpreted in terms of the problem and suggestions for a new or refined design are evident.

4 The design is as stated above but the evaluation/explanation stage is not evident.

3 More than one stage of the design is missing or in error, or the data collection or analysis is incomplete or poorly done.

2 Errors are evident in the design, it si poorly constructed and will not provide sufficient evident to assist the intent of the assignment

1 No understanding of the problem-solving strategies or experimental design strategies that are essential to the assignment.

0 Not done or handed in.

The scoring of laboratory/experimental design assignments could also include a component for the displaying of communication skills such as:

COMMUNICATION SKILLS

The students response demonstrates the required components for good communication of the assigned task.

5 Ideas are well presented and communication is impressive.

4 Ideas are presented and communicated.

3 Several minor errors are evident in the presentation, and communication has been somewhat interrupted by these errors.

2 Errors are evident that result in disjointed communication, or in some cases no communication.

1 The material presented does not communicate the intended task.

0 Not done or handed in.

TEST QUESTION: (Experimental Design)

Design an experiment to determine whether a household substance is an acid or a base. Include in your design nine specific substances to illustrate acids, bases and some substances that are neither. Your design should give enough information for a classmate to test their prediction that a given substance is or is not an acid or a base. Describe one way that your design could be evaluated.

(15 marks)

The question would be marked with 12 marks for the experimental design and 3 marks for the ability of the student to communicate their design. These marks would be arrived at through the application of the scales previously presented to students for their work.

PROBLEM-SOLVING STRATEGIES	mark out of 5 x (12/5)
COMMUNICATION SKILL	mark out of 5 x (3/5)

LIBRARY ASSIGNMENT: Modern Technological Devices and Science

Briefly describe how any two of the following modern devices works. Specify what scientific principle had to be understood in order to develop the device. Discuss the advantages and disadvantages of the use of this technology.

List: **Telephone, Light, Microscope, Ultrasound Technology, X-ray, Lasers, <u>or technology of your choice</u>.**

Your mark for this exercise will be based on the accuracy and clarity of the information reported and the understanding of the science and technology involved.

The weighting of marks for this assignment will be as follows: There will be 10 marks for the <u>SCIENCE AND TECHNOLOGY</u> component of the assignment and a further 5 marks for the <u>WRITING SKILLS</u> component for a total of 15 marks on the assignment. The marks will be assigned in accordance to the following scales:

<u>SCIENCE AND TECHNOLOGY</u>	<u>COMMUNICATION (ORAL AND WRITTEN) SKILLS</u>
The work displays an understanding of the technology and the science associated with that technology.	The work is effective in creating an impression that demonstrates control of diction, syntax, mechanics and grammar.
5 Technology and science are correct, relation between them is made explicit, and an understanding of the need for this technology is understood.	5 Writing is skillfully structured and fluent so that the meaning is clear. Diction is appropriate, syntax controlled and relatively absent of errors.
4 Either the technology or the science (but not both) is misrepresented or misunderstood.	4 Writing is clear and generally fluent. Diction is appropriate and syntax is controlled. Minor errors do not reduce the clarity of communication
3 Neither the technology or science are clearly presented.	3 Writing is clear. Diction adequate, syntax generally straightforward but awkward and errors reduce but seldom impede communication.
2 The science presented is not related to the technology; or the science and technology presented are not associated with each other.	2 Writing is unclear or ineffective. Meaning must be supplied by the reader. Diction inappropriate, syntax awkward and errors impede communication
1 Misunderstanding of the science and the technology that are presented is evident.	1 Writing frequently not fluent. Diction inaccurate, syntax uncontrolled and errors severely impede communication.

FOCUSED MARKING SCALE

7. EXCEPTIONAL

- content: ideas, organization and development command attention and respect
- an impressive style evident from word choice, usage and sentence structure
- mechanical skill accurate and effective in relation to purpose
- accurate spelling

6. SUPERIOR

- content: most ideas are significant; well organized and developed
- sentence structure and word choice clear and effective; accurate usage
- mechanical skills relatively error free in relation to purpose
- relative free from spelling errors

5. COMPETENT

- content: several significant ideas; minor problems in organization and development
- minor problems in word choice, and/or sentence structure
- frequent mechanical errors
- few spelling errors

4. MARGINAL

- content: a few relevant ideas; some evidence of organization but with deficiencies in development
- many flaws in word choice and/or sentence structure
- many distracting mechanical errors
- numerous, distracting spelling errors

3. UNSATISFACTORY

- content: insufficient number of ideas; disorganized, inadequate development
- many flaws in word choice and/or sentence structure
- many distracting mechanical errors
- numerous, distracting spelling errors

2. MAJOR DEFECTS

- content: lacking in ideas, or organization, and/or development
- serious deficiencies in word choice and/or usage and/or sentence structure
- extensive mechanical errors
- extensive spelling errors

1. INSUFFICIENT DATA AND/OR OFF TOPIC

(Developed by Program Evaluation and Language Arts Team, Calgary Board of Education)

ANALYTICAL EVALUATION

Analytic scales direct the reader's attention to specific features of the writing and suggest relative point values for each feature. The grade is arrived at by summing scores on the various subsections. Such a scoring tool is more specific than impression marking because the rating guide defines and illustrates criteria for both writes and raters alike. Such guides, explained to students, demystify the final grade and highlight strengths and weaknesses in writing. The guide also directs that certain surface features (handwriting, spelling, punctuation) do not overwhelm the rating (Kirby and Liner, *Inside Out*).

	4	3	2	1
Content • main idea or focus				
• main idea expressed in topic sentence*				
• adequate support for main idea				
• appropriate details				
• concrete details				
Organization • introductory matter				
• orderly development from ideas to ideas				
• sense of conclusion				
Word Choice • vivid and specific words				
Sentence Structure • correct sentence structure				
• varied sentence structure				
Mechanics • correct capitalization				
• correct punctuation				
• correct spelling				
• correct paragraphing				
Usage • correct agreement and reference				

* where appropriate

ANALYTIC MARKING SCALE

OBJECTIVE	SCALE
1. Introduction	4 – Introduction commands attention 3 – Introduction satisfactory 2 – Introduction unsatisfactory 1 – Insufficient evidence
2. Conclusion	4 – Conclusion commands attention 3 – Conclusion satisfactory 2 – Conclusion unsatisfactory 1 – Insufficient evidence
3. Focus on topic	4 – Ideas relate to topic 3 – Fluctuation but focus is on topic 2 – Deviates from topic 1 – Insufficient evidence
4. Topic development	4 – Originality of ideas creates impact 3 – Ideas ordinary and functional 2 – Insufficient number of ideas 1 – Insufficient evidence
5. Organization	4 – Well–organized and coherent paragraph–topic clearly identified 3 – Usually conveys ideas smoothly 2 – Coherence weak 1 – Insufficient evidence
6. Word choice	4 – Word choice correct and impressive 3 – Word choice ordinary but functional 2 – Word choice restricted 1 – Insufficient evidence
7. Usage	4 – Usage attracts little or no attention 3 – Few errors which do not detract from impact 2 – Errors detract from readability and impression 1 – Insufficient evidence
8. Sentence structure	4 – Sentences are completed and well–constructed 3 – Sentences are complete but awkward (2 or more errors) 2 – Sentences are incomplete or run on (2 or more errors) 1 – Insufficient evidence
9. Variety in sentence patterns	4 – Good variety of sentence structure 3 – Some variety in sentence structure 2 – Errors detract from readability and impression 1 – Insufficient evidence
10. Punctuation and capitalization	4 – Punctuation and capitalization attract no attention 3 – Errors do not detract from impact 2 – Errors detract from readability and impression 1 – Insufficient evidence
11. Spelling	4 – Spelling attracts no attention 3 – Errors do not detract from impact 2 – Errors detract from readability and impression 1 – Insufficient evidence

SAMPLE CRITERIA FOR RATING FORMAL PRESENTATIONS

The following criteria can be used to determine content and presentation ratings for the STUDENT PROFILE on the following page.

Content

5 Relevant to topic; appropriate to audience; organized so that listeners can follow/anticipate easily. Explicit introduction and conclusion. Attempt to capture and maintain audience interest. Sufficient length.

4. Relevant to topic; appropriate to audience. Attempt at logical sequence apparent but may falter. Explicit introduction and conclusion. Sufficient length. May not interest or entertain audience.

3 Generally relevant and appropriate, but may occasionally "wander" from topic. Explicit introduction, but conclusion may be weak. May not interest or entertain audience.

2 Deficient in at least one important area – may include a large proportion of irrelevant or inappropriate material, fail to introduce or follow a logical sequence, or be deficient in length.

1 Little preparation evident. Insufficient material, poorly organized.

Presentation

5 Poised and confident. Voice is audible and animated. Establishes contact with audience.

4 Attempts confident stance. Voice is audible and clear, but may not be animated. Some contact with audience.

3 Presentation can be clearly understood, but anxious or nervous mannerisms – fidgeting, over-reliance on notes, failure to make contact with audience – detract from effectiveness.

2 Attempts to speak to audience but frequently difficult to hear or understand. May include repeated instances of "fillers" or uncomfortable pauses or hesitation.

1 No attention to audience. Difficult to hear or understand.

RATING SCALE: PRESENTATION FEATURES

Name:______________________ Date:______________________

Task/Topic: ____

____

		WEAK	FAIR	GOOD	GOOD
1.	Spoke clearly and audibly	☐	☐	☐	☐
2.	Showed interest and enthusiasm through voice/gestures	☐	☐	☐	☐
3.	Showed awareness of audience	☐	☐	☐	☐
4.	Spoke fluently	☐	☐	☐	☐
5.	Show presence/confidence through stance	☐	☐	☐	☐
6.	Stayed on topic	☐	☐	☐	☐

OVERALL RATING:

Weak ☐ Fair ☐ Good ☐ Very Good ☐

Comments:

Enhancing and Evaluating Oral Communication in Secondary Grades, Ministry of Education, Province of B.C., 1988

SCIENCE 14
SAMPLE ACTIVITIES

REQUIRED UNIT I: BODY SYSTEMS

Overview

Through the application of scientific investigation, and the incorporation of simple monitoring technology, students will be encouraged to develop an understanding of the human body as a collection of dynamically balanced processes. The contribution of science to the current knowledge and technology associated with an aspect of the functioning human body will be identified. Knowledge gained should be personally applicable and form a foundation for understanding the life processes of all living organisms.

The emphasis of this unit is the nature of science.

SPECIFIC LEARNER EXPECTATIONS

Attitudes

The student will be encouraged to:

- appreciate the potential for advancement of knowledge through scientific inquiry
- respect the method of scientific investigation for its contribution to current knowledge of body systems and their interactions
- value the contribution of technology to the scientific investigations related to human health
- appreciate the intricate workings and balance within the human body
- value knowledge gained for its usefulness on a personal level
- value knowledge gained for its general application to all living things.

Skills

The student will be expected to demonstrate an ability to:

- question, observe, measure, collect, process, and interpret data while investigating body systems
- apply monitoring technology in the collection of personal data for analysis.

Concepts

Students will be expected to demonstrate an understanding that:

1. **Science is a disciplined way to develop explanations for body functions.**

   1.1 Illustrate with an example that much of our current knowledge of body systems has developed as a result of scientific inquiry.
   1.2 Outline a scientific investigation of a specific body function.
   1.3 Deduce that the knowledge of body systems is constantly expanding through scientific research.

Students will be expected to demonstrate that:

2. **Medical technology can be used to monitor body conditions.**

   2.1 Describe the role of technology in monitoring critical life functions.
   2.2 Describe the contribution of technology to the diagnosis of malfunction within body systems.
   2.3 Explain using an example how science and technology work together to expand knowledge of body systems, providing information that can be applied to prevention of potential problems.
   2.4 Describe how technology can intervene to preserve the balance of life when a system fails (temporary and permanent intervention).

Student will be expected to demonstrate an understanding that:

3. **A healthy body is the product of body systems working in harmony.**

   3.1 Identify the critical life functions and the body system(s) that perform(s) them.
   3.2 State how each body system has a particular function critical to life.
   3.3 Describe two body systems and their functions.
   3.4 List the structures within those two body systems.
   3.5 State the functions associated with each of those structures within the two systems.
   3.6 Analyze the functional relationship of these two systems.

Students will be expected to demonstate an understanding that:

4. **The interrelationships of body systems are critical to life.**

   4.1 Explain how normal fluctuation within one body system results in adjusting fluctuations in other body systems.
   4.2 Analyze the effect of a major fluctuation within the normal limits of one of the two systems studied.
   4.3 Extrapolate the concept to include the interrelationships of all body systems.
   4.4 Deduce that illness and possibly death results when the body cannot accommodate major disturbances within one or more of its systems.

Student will be expected to demonstrate an understanding that:

5. **Living things share common life functions.**

   5.1 Describe how critical life functions are performed by unicellular organisms, plants, and animals.
   5.2 Generalize and apply knowledge gained about human life functions to other living systems.

NOTE: It is the teacher's or students' choice as to which of the two body systems to study in this unit. However, it is important to cover all specific learner expectations.

CONCEPT 1: Science is a disciplined way to develop explanations for body functions.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 Illustrate with an example that much of our current knowledge of body systems has developed as a result of scientific inquiry.	• Observe, through study, the developments that have progressed from the use of the microscope: a) make a drawing of a simple microscope that Robert Hooke made in 1655 b) compare the simple microscope of Hooke to one made by Carl Zeiss and Ernst Abbe in 1866 c) find out the differences between an electron and light microscope d) look at pictures of cell parts taken from an electron microscope • Read the story of William Beaumont and his patient (called the St. Martin experiment) about the process of digestion as chemistry.	*Your Body in Balance*, p. 13 *Man–Made Wonders* *Technology at Work* *Technology at Work* *Great Scientific Experiments*
1.2 Outline a scientific investigation of a specific body function.	• Draw a chart showing the major scientific breakthroughs in biology. Choose a body system and arrange the information to show the progression of scientific research in that area. NOTE: Additions to the chart may be made following the other units • What system(s) do we know much more about now due to scientific research? – Use films, filmstrips and videos to illustrate • Discuss how our knowledge of the digestive system has been increased due to x–rays and the endoscope	*Your Body in Balance*, p. 14 *Your Body in Balance*, p. 30
1.2 Deduce that the knowledge of body systems is constantly expanding through scientific research.	• List the steps that Robert Koch followed to develop a vaccine. • Research the work of Louis Pasteur. • List the steps of the scientific process that John Snow (1813-1858) incorporated into his study of the cholera epidemic.	*Great Scientific Experiments* *The Experience of Science*

CONCEPT 2: Medical technology can be used to monitor body conditions.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Describe the role of technology in monitoring critical life functions.	• Take pulse rate manually and with a stethoscope. • Use a blood-pressure gauge to find students' blood pressure. (Experimental results may be compared to known results.) Note: if equipment is not available, try to a) incorporate a trip to a lab or hospital or b) ask the health unit nurse to come in and demonstrate.	*Your Body in Balance*, pp. 9, 15–16, 46–49 *Your Body in Balance*, pp. 16–21
2.2 Describe the contribution of technology to the diagnosis of malfuntion within body systems.	• Ask the medical lab or doctor for: – a normal electrocardiogram (ECG) printout – an abnormal ECG printout – students can draw an ECG pattern in their notebooks and in their own words explain what happens when the heart beats (relaxation and pumping). • The heart pulse may be taken manually or with a stethescope. • How does a stethescope function? • Take readings of the heart rate – sitting – standing – after running on the spot for two minutes or step-ups.	*Your Body in Balance*, pp. 9, 15, 46–48 *Principles of Science II*, pp. 35–43
2.3 Explain, using an example, how science and technology work together to expand knowledge of body systems; provide information that can be applied to prevention of problems.	Obtain (old) X-rays from a hospital. Students observe X-rays and identify the bones shown. • Who was Wilhelm Roentgen? How did his work advance science and technology? • Draw a colourful picture depicting the brain/skull. • What is an endoscope and how does it work?	*Smithsonian Book (II)* *Your Body in Balance*, p. 30 *Smithsonian Book II*, *National Geographic*, *Future Life* *Your Body in Balance*, pp. 29–30

CONCEPT 2 (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.4 Describe how technology can intervene to preserve the balance of life when a system fails (temporary and permanent intervention).	• Observe pictures of the body taken by x-ray and by scanners: – magnetic resonance imaging (MRI) – computed tomography (CT) or computerized axial tomography (CAT) – sonography – position emission tomography (PET). • What are the advantages of diagnostic imaging? • Are there limitations to the method? • Tell me what you know about dialysis? Draw a simple diagram portraying how a kidney dialysis operates or explain it in your own words. • List artificial body parts which have been implanted (e.g., " Jarvik Heart"). Discuss moral and ethical implications. • What are lasers? How have they been used in human eye surgery? • Prepare a research report on a recent organ transplant recipient.* • What new accomplishments in the transplant field may occur in the future (the next 5, 10, 15 years)?* • Are there alternatives to the technology route? *NOTE: Transplants will be covered in Science 24 Unit I. Disease Defence.	*Your Body in Balance*, pp. 43–44 *National Geographic* (x-rays): *Your Body in Balance*, pp. 30–31 *Future Life* *Principles of Science II*, pp. 62–64 *Technology at Work*

CONCEPT 3: A healthy body is the product of body systems working in harmony

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Identify the critical life functions and the body system(s) that perform them.	• Identify organs that, once removed or diseased (from the system), cause disruption and malfunction. • Observe changes in heart rate and pulse. – sitting, standing, after jogging on the spot for 1 minute • What is blood pressure? What factors affect heart rate? What is making the sound of the heartbeat? • Why do we need oxygen? • What happens if blood does not travel back to the heart during a hemorrhage? (less blood volume, less pressure – the body in shock) • Do you know anyone who is blind? How can we modify our environment to meet the needs of the blind? • :How does paralysis occur? <u>Note</u>: The following topics are covered in the Disease Defense unit at the 24 level. a) Diseases, Viruses & Bacteria b) Immune System c) Heart Disease d) Cancer e) Diabetes • Do you know anyone who has or has had cancer? How does it affect normal functions? • How do you think cancer occurs? (Briefly discuss how normal functioning is upset). • Do you know anyone who has an ulcer? Explain the diet of an ulcer patient. • People with a malfunctioning colon or rectum often require surgery and have the organ removed. • Explain a Colostomy and how it replaces the functioning part. • Name some diseases of the intestinal tract, i.e., Colitis.	*Your Body in Balance* p. 21 *Science at Work: Body Maintenance* pp. 22-26 *Your Body in Balance,* pp. 6–21, 46–47 *Ostomy Society and Aids to Daily Living*
3.2 State how each body system has a particular function critical to life.	• Set up a demonstration to illustrate that parts function together to make a whole existing structure (system): a) an assembly line: with interlocking blocks (e.g., Lego) have student #1 pass a shape to student #2, then add—then pass to #3, etc. b) wheel and cog motion. • Compare and contrast the functioning of body systems to the functioning of a motorcar.	

CONCEPT 3 (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.3 Describe two body systems and their functions.	• "Parts" work together to form systems. What "parts" work together to form the school system? • The learner will demonstrate knowledge of a system by: a) labelling a diagram of all parts of two body systems; e.g., digestive system, respiratory systems. b) drawing a system on a large sheet of bristol board, draw a diagram showing how blood circulates through the heart, naming major vessels. • Ask for a student volunteer to stand on a chair in front of a screen. Project an overhead transparency onto the person (note: a person wearing a white shirt works best)	
3.4 List the structure(s) within those two systems.	• Students will apply knowledge and understanding of the system by showing a partner the various parts of the system on a blank diagram. (Partner will judge the labels.)	
3.5 State the functions associated with each of those structures within the two systems.	• Match the functions of each part of the system: a) with index cards: one partner reads the function and the other identifies the part corresponding to it. A reference may be used. (Answer is located on the back of the index cards) b) using the cards: mix up the two systems, and sort the cards into the respective systems. • Prepare a list of organs and their functions. • Demonstrate understanding of a system by explaining to the class, one part of that system and its function. • Dissect a frog and identify the structures of the system. a) <u>**Skeletal System**</u> – support, movement and production of blood cells – what is inside a bone? (cut open a bone and observe the marrow) – observe the design of bones for movement (e.g., joints—hinge; ball and socket) – identify major bones of a skeleton – identify bones from x-rays – construct a life-size skeleton from paper	*Your Body in Balance*, pp. 38–40 *Science at Work: Body Maintenance*, p. 14. *Body System in Balance*, pp. 78–85 *Principles of Science*, pp. 24–28

CONCEPT 3 (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.5 State the functions associated with each of those structures within the two systems.	a) <u>Skeletal System</u> (continued) – discuss bone marrow transplants and artificial limbs – discuss first-aid techniques used for broken bones. b) <u>Digestive System</u> – food as fuel: How is energy released from peanuts, and used to heat water? – how much energy is found in certain foods? – what are catalysts? how do they act to break down food? • How do the endocrine system and digestive system work together to function normally? – Do elective: Food Power (Nutrition)	*Science at Work Body Maintenance*, pp. 14–15 *Body in Balance*, pp. 22–30 *Principles of Science II*, pp. 66–74
3.6 Analyse the functional relationship of these two systems.	c) <u>Circulatory System</u> – dissect a sheep's heart and identify the structures – observe circulation of blood in a fish tail – show the effect of adrenalin on circulation in a fish (set up a demo) – observe blood cells and note how their structure relates to the functions (Use of a <u>microslide viewer</u> is more beneficial than prepared red blood cell slides because they are larger and the white blood cells can be seen more readily. d) <u>Respiratory System</u> – how much air can you breathe and how much do you breathe? – make a model to demonstrate diaphragm breathing – test for the presence of carbon dioxide – helping others to breathe—artificial respiration – breathing under water—scuba, etc. – as you increase pressure, what happens to the volume of air trapped inside a container? – how do other organisms employ direct and indirect gas exchange in breathing? e) <u>Nervous System and Senses</u> – how does the skin detect change?	*Your Body in Balance*, pp. 5–11, 14–21, 11–12, 50–51 *Science at Work Body Maintenance*, pp. 22–32 *Principles of Science II*, p. 44 *Your Body in Balance*, pp. 54–62 *Science at Work Tik Liem*, p. 252 *Body Maintenance*, pp. 16–19 *Principles of Science II*, pp. 59–62 *Tik Liem*, pp. 350–352 *Principles of Science II*, pp. 79–92 *Science at Work Body Maintenance*, pp. 3–5

CONCEPT 3 (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.6 Analyse the functional relationship of these two systems.	f) <u>Endocrine System</u> – how does the skin detect change? – vision – hearing, taste and smell – draw diagrams to illustrate the internal body processes that the autonomic system regulates – measure body temperature – drugs and the nervous system.	*Your Body in Balance*, pp. 63–67 *Your Body in Balance*, pp. 38–41 *Food Power*, pp. 33–39

CONCEPT 4: The interrelationships of body systems are critical to life.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Explain how normal fluctuation within one body system results in adjusting fluctuations in other body systems.	• With reference to the lab on heart rate and blood pressure, ask what external changes occurred: a) analyse how a home thermostat functions b) compare and contrast this to the temperature "feedback system" of the body.	*Your Body in Balance*, pp. 14–19
4.2 Analyse the effect of a major fluctuation within the normal limits of one of the two systems studied.	• In an emergency situation normal body systems fluctuate: a) list the external changes (e.g., clammy skin, sweaty palms, paleness) b) list the internal changes that may be felt (e.g.,"heart in throat feeling") c) create your own feedback system to illustrate how the following are controlled: – blood sugar – metabolic activity – dilation of pupils – breathing and heart rate – body temperature – muscular movements – skin sensation.	*Your Body in Balance*, pp. 38–42 *Your Body in Balance*, pp. 63–67 *Your Body in Balance*, pp. 6–19, 58 pp. 46–47
4.3 Extrapolate the concept to include the inter-relationships of all body systems.	• List some stressful situations that cause fluctuations in the body. For example: i) how does smoking effect the body? ii) anemia iii) hemophilia Both short-term and long-term effects can be studied.	*Your Body in Balance*, pp. 55–62, 51–53
4.4 Deduce that illness and possible death results when the body cannot accommodate major disturbances within one or more of the body's systems.	• Discuss the premise in Hans Selye's book *Stress Without Distress* that both positive and negative stressful situations can lead to serious malfunctions within body systems, resulting in death. • Do you know someone who has experienced a heart attack? • What does "heart attack" mean? • Describe the events that lead up to a heart attack and the results that follow. • What factors may influence the proper functioning of the heart?	*Stress Without Distress* Hans Selye *Your Body in Balance*, pp. 51–52

CONCEPT 5: Living things share common life functions.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
5.1 Describe how critical life functions are performed by unicellular organisms, plants and animals.	• Observe a simple animal. Look at general body structure. Why is it called a simple animal? • Observe a complex animal's general structure. • Illustrate comparative anatomy and physiology (body system structure and function) in both simple and complex animals. • Compare the system studied with that of: – a paramecium – an earthworm – a grasshopper – a frog (by dissection). • Plants have a transport system also. Water and food must be distributed in order for the plant to survive. – observe transport of fluids in a celery stalk	*Your Body in Balance*, pp. 70–73, 78–85 *Your Body in Balance*, pp. 78–85 *Your Body in Balance*, pp. 70–85 *Your Body in Balance*, pp. 71–85 *Your Body in Balance*, pp. 69–70
5.2 Generalize and apply knowledge gained about human life functions to other living systems.	• The cell is the basic unit of structure and function of all living things a) Observe prepared slides of animal cells under a microscope. How are they alike and how are they different? (Microslide viewers are useful. Cells are larger and it is easier than a compound microscope to use.) b) Observe plant cells under a microscope. How do they compare in structure and function to animal cells	*Principles of Science II*, pp. 20–23 *Your Body in Balance*, p. 55

Topics of Interest for Projects
Unit I: Body Systems

1) artificial hearts, valves, pacemakers*
2) high blood pressure
3) a no-salt diet
4) causes of heart attack
5) arteriosclerosis
6) stroke
7) asthma
8) lung cancer*
9) emphysema
10) epilepsy
11) drugs and the nervous system, choose one type; e.g., anti-depressants
12) arthritis
13) pneumonia
14) anemia
15) chronic bronchitis
16) peptic ulcers
17) diseases of the bowel
18) diabetes mellitus
19) cirrhosis
20) obesity
21) anorexia, bulemia
22) food poisoning
23) leukemia*
24) being blind
25) being deaf
26) physical disabilities

*Note: The following topics may overlap with Science 24 Unit I: Disease Defence.

SQ3R is an efficient reading strategy that can be used when students are doing research projects, pages 76–77. Research strategies are dealt with on pages 91–102. Sample research projects are on pages 103–109.

UNIT II: HOUSEHOLD SCIENCE

Overview

By carrying out a series of controlled experiments, students will identify properties of substances found in their homes. They will be expected to develop a strategy for the safe handling of potentially dangerous substances and situations encountered within the home environment.

The emphasis of this unit is the nature of science.

SPECIFIC LEARNER EXPECTATIONS

Attitudes

The student will be encouraged to:

1. Value scientific principles processes for their usefulness in providing an understanding of common household phenomena.
2. Appreciate that science exists outside of the classroom and laboratory.
3. Value measurement for its usefulness in the household
4. Appreciate the benefit and potential danger of common household chemicals.
5. Appreciate the contribution of technological products and processes to the modern household.

Skills

The student will demonstrate an ability to:

1. Improve their measurement skills.
2. Refine their observational skills.
3. Use their data collection, processing and interpreting skills.
4. Communicate experimental results clearly.
5. Read consumer information with accuracy and understanding.
6. Determine household product composition through investigation and/or accurate label reading.
7. Determine the properties of pure substances and solutions through investigation.
8. Apply acid and base identification techniques.
9. Protect living organisms and materials from excessive heat transfer.
10. Handle food safely.
11. Handle potentially dangerous household products safely.

Concepts

Students will be expected to demonstrate an understanding that:

1. **Household activities often require knowledge of measurement techniques.**

    1.1 Use a variety of measurement techniques used in a household.
    1.2 Use common household measurement devices correctly.

Students will be expected to demonstrate an understanding that:

2. **Household products and processes are based on the principles of science.**

   2.1 Identify some basic household processes (such as cleaning, laundry, baking and painting) which are based on scientific principles.
   2.2 Identify the products involved in these processes (e.g., detergents, solvents, leavening agents).
   2.3 Explain the composition of a household product.
   2.4 Describe the scientific principles which underlie the effectiveness of a household product or process.

Students will be expected to demonstrate an understanding that:

3. **The properties of solutions are different than those of pure substances.**

   3.1 Describe the properties of solutions and pure substances.
   3.2. Identify pure substances found in a household.
   3.3 Identify solutions found in a household.
   3.4 Differentiate solutions and pure substances, using selected household examples.

Students will be expected to demonstrate an understanding that:

4. **Permanent suspensions are found in the home.**

   4.1 Describe the properties of permanent suspensions.
   4.2 Identify common permanent suspensions found in the home.
   4.3 Deduce the importance of permanent suspension by examining the consequences of separation to relevant household products.

Students will be expected to demonstrate an understanding that:

5. **Acids and bases can be identified and their reactions observed in the home.**

   5.1 Describe the necessity for accurate identification of these substances.
   5.2 Describe how acids and bases can be identified.
   5.3 Illustrate with an example how acids and bases can react with other household substances in both useful and potentially dangerous ways.

Students will be expected to demonstrate an understanding that:

6. **Solubility varies with temperature change.**

   6.1 Describe how temperature change affects solubility of one common household solute.
   6.2 Cite common household examples of temperature change affecting solubility (e.g., brine preparation in pickling; syrup preparation in canning of fruit; making jello; and home-made syrup).
   6.3 Describe why certain solutes crystallize out as temperature drops—and explain the concept of saturation point.

Students will be expected to demonstrate an understanding that:

7. **Reactions may require or emit energy in the form of heat.**

    7.1 Describe the types of household reactions that require heat.
    7.2 Describe different household chemical reactions that would produce heat.
    7.3 Evaluate the usefulness of household reactions that or require or emit heat.

Students will be expected to demonstrate an understanding that:

8. **Heat flows from areas of high temperature to areas of lower temperature.**

    8.1 Compare heat exchange by conduction, convection, and radiation in different mediums.
    8.2 Determine the mode of heat transfer involved in various household processes.
    8.3 Describe how household products, devices and techniques are designed to increase or decrease heat flow for specific purposes.
    8.4 Describe the potential dangers of heat transfer.

Students will be expected to demonstrate an understanding that:

9. **Many household substances require special care in their use and handling.**

    9.1 Identify substances that have safety labelling.
    9.2 List reasons why reading instructions for safe handling is important.
    9.3 Describe recovery techniques for common problems or errors in handling.
    9.4 List the potential dangers of mixing certain household products.
    9.5 Describe how micro–organisms can have beneficial and harmful effects on food material in the home.

CONCEPT 1: Household activities often require knowledge of measurement techniques.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 Use a variety of measurement techniques used in a household.	• Have student identify the various measurement apparatus used at home.	*Household Science*, p. 10
1.2 Use a number of common household measurement devices correctly.	• Take measurements of length (mm, cm, m) of: – a stereo – a car – classroom. • Of the three measurements of length, which is the most meaningful to the students' use? • Make a list of things measured in volume. • Use kitchen measuring devises to measure volumes, compare their accuracy to those used in the science lab. • Take the mass of cornflakes (1 cup). • Check measurements of a: – soft drink can – candy bar – milk carton – student's height – use an electronic balance or pan balance and determine the mass of one small candy, or a wheat puff. • Ask the students to choose an object (e.g., car engine/walkman/television) that they would like to know the measurements of and measure it. • Why do we measure? • Check the temperature on a daily basis for one week and plot graph. Compare results to the average highs and lows for the day. • Find the special measuring devices used in a building construction lab and/or automotives lab. What do they measure? • Check the weight of a bag of fertilizer. • Find out how many milliliters or liters of milk will one milk cow give. • Find the volume of a sugar cube. What volume of sugar makes a very sweet cup of tea/coffee? • How many milliters in a dropper? How many drops in a dropper? (count drops in 10 ml and find drops/ml, then get a class average.)	*Applied Science I*, pp. 30–32 *Household Science*, pp. 10–12 *Household Science*, pp. 13–15, 18–21

CONCEPT 2: Household products and processes are based on the principles of science.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Identify some of the basic household processes that are based on scientific principles (e.g., cleaning, laundry, baking and painting).		
2.2 Identify the products involved in these processes (e.g., detergents, solvents, leavening agents).	• Collect labels of common household products • Find common ingredients in each (e.g. water, alcohol, oil). • Classify the product into categories: – floor cleaner – detergent – soap – baking product (e.g., meat tenderizer) – paint cleaner – paint.	
2.3 Explain the composition of a household product.	• Expand on the chart above, listing the components of the various products.	
2.4 Describe the scientific principles which underlie the effectivenss of a household product or process. Differentiate between solutions and pure substances, using the selected household examples.		

CONCEPT 3: The properties of solutions are different than those of pure substances.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Describe the properties of solutions and pure substances.	• What do you know about solutions? – define **solute** and **solvent** – define **soluble** and **insoluble** – make a solution and classify it as a **mixture** or a **compound**.	*Household Science*, pp. 51–57 *Applied Science II.* Unit 4,pp. 22–23 *Principles of Science II* p. 321–322
3.2 Identify pure substances found in a household.*	• Find out if all substances dissolve in water – alcohol and water – oil and water – vinegar and water – turpentine and water.	*Concepts and Challenges*, Bk. 2, pp. 70–72
3.3 Identify solutions found in a household.*	• Examine solvents other than water. Discuss solvents used in dry cleaning. • Create a television or radio commercial or advertisement for your new spot remover, or cleaner.	*Applied Science II* p. 24 *Principles of Science Teacher's Guide*, p. 133
	• Using the chart from Concept 2. 2., check which products are/are not pure substances.	

*Consider different home environments of the students.

CONCEPT 4: Permanent suspensions are found in the home.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Describe the properties of permanent suspensions.	• Set up a demonstration of a suspension. Ask students to describe what they see. a) What happens to the particles in a suspension when it is left standing? b) What is a suspension? c) How can particles from a suspension be removed? d) Draw a table comparing liquid solutions and suspensions.	*Household Science*, pp. 70–75 *Principles of Science II*, pp. 326–327
4.2 Identify common permanent suspensions found in the home.	• Identify the substances which make up common household suspensions.	*Household Science*, p. 72
4.3 Deduce the importance of permanent suspension by examining the consequences of separation relevant to common household products.	• How is milk homogenized? • Describe how cream and butter are made.	

CONCEPT 5: Acids and bases can be identified and their reactions observed in the home.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
5.1 Describe the necessity for accurate identification of these substances.	• Examine the warning labels on a number of household products. • Discuss what would happen if you used ammonia in place of vinegar or vice-versa since both look alike.	
5.2 Describe how acids and bases can be identified.	• How can <u>acids</u> be recognized? (Note: known acids can be used first, or one can combine both solutions and substances of acids & bases and classify them afterwards.) Identify known common acids: battery acid, citric acid, boric acid, milk (buttermilk), vinegar, aspirin. – acids taste sour – acids turn blue litmus paper red – acids wear away metals – acids cause colour changes. • Ask students to identify <u>bases</u>. Identify known common bases: milk of magnesia, lye, ammonia, baking soda, fertilizer – bases taste bitter – bases feel slippery or soapy – bases turn red litmus paper blue – bases destroy the properties of an acid – dissolve fats & oils. What effect does a base have on oil? • Use indicators to identify acids and bases. • Acids & bases can be tested for relative strengths using pH indicator paper and rank on the pH scale. • Explain that the pH scale is a unit of measurement (this can be information from Concept 1—Measurement).	*Household Science*, pp. 23–30 *Applied Science* Unit 5 Bk2, pp.25–28 *Household Science*, pp. 23–27 *Principles of Science II*, pp. 314–316 *Concepts and Challenges*, pp. 107–113 *Household Science*, pp. 25–26 *Principles of Science*, pp. 316–317 *Household Science*, p. 28 *Principles of Science II*, pp. 319–320

CONCEPT 5 (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
5.3 Illustrate with an example how acids and bases can react with other household substances in both useful and potentially dangerous ways.	• What happens when an acid is mixed with a base? • Make soap from household products (lye & fat). • Make a detergent.	*Household Science*, pp. 29–30 *Principles of Science II*, p. 340 *Principles of Science II*, p. 341
	• Compare the cleansing action of a soap and a synthetic detergent. • Construct a chart after testing the household products in order to classify them on the properties studied. – type of solution – acid or base – strength according to the pH scale – reactions observed in the home – potential dangers.	*Principles of Science II*, pp. 340–341

CONCEPT 6: Solubility varies with temperature change.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
6.1 Describe how temperature change affects solubility of one common household solute.	• How can we make solutes dissolve faster? a) stirring b) hot and cold solutions – how does temperature affect the solubility of a solid in a liquid: sugar & water, tea/coffee in water, gelatin crystals in water, salt and water, soil and water, and oil and water?	*Principles of Science II*, p. 324 *Household Science*, pp. 51–63
6.2 Site common household examples of temperature change affecting solubility (e.g., brine preperation in pickling, syrup preparation in canning of fruit, making gelatin, and homemade syrup).	• Will more solids dissolve in 100 ml of water at 25° C or at 75° C? • Would more gas usually dissolve in 100 ml of water at 25° C or at 75° C?	*Household Science*, p. 63 *Principles of Science II*, pp. 325–326
6.3 Describe why solutes crystallize out as temperature drops and explain the concept of saturation point.	• What do you know about a saturated solution? • Give examples of a saturated solution. a) make a saturated sugar solution. b) which contains more dissolved sugar—a cold saturated solution or a hot saturated solution? • Make a supersaturated solution to show how rock candy can be formed.	*Household Science*, pp. 64–69 *Principles of Science II*, p. 325 *Household Science*, p. 69

CONCEPT 7: Reactions may require or emit energy in the form of heat.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
7.1 Describe the types of household reactions which require heat.	• gravies and sauces • melting—butter, chocolate • humidifier • most dissolving reactions	*Household Science*, pp. 39–40
7.2 Describe different household chemical reactions which produce heat.	• refrigeration • air conditioning • home heating • drain cleaner • epoxy-type reactions	*Household Science*, p. 49 *Principles of Science II*, p. 372 Household Science, p. 39 *Principles of Science II*, pp. 376–377 *Household Science*, p. 31
7.3 Evaluate the usefulness of household reactions that require or emit heat.	• Use the above reactions to illustrate usefulness.	

CONCEPT 8: Heat flows from areas of higher temperature to areas of lower temperature.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
8.1 Compare heat exchange by conduction, convection and radiation in different mediums.	• How do we feel heat? How may heat be transferred? • Heat is transferred by conduction: – metals are good conductors of heat—make observations and list the utensils found in the home that conduct heat – list poor conductors of heat—test heat transfer in a metal spoon with a plastic handle and one with a wooden handle – heat transfer by conduction can be demonstrated using a candle (wax), metal knitting needle and glass rod.	*Household Science*, pp. 41–44 *Principles of Science II*, p. 367
8.2 Determine the mode of heat transfer involved in various household processes.	• Heat is transferred by convection: – ask what happens to the temperature of water as it is heated – explain and draw a diagram illustrating convection currents in a home – explain how convection in a refrigerator works. • Radiation – what is solar radiation? – ask what makes the best radiator (add water to a black painted can and to an unpainted can and place in direct sunlight. Which can had the lowest temperature after 15 minutes, which can lost the most heat after 15 minutes?) – investigate the principle of a solar heated home. – build a model of a passive solar home. • Insulation is any substance that slows or controls the movement of heat energy—observe how insulation works using simple materials. • Examine such products as vacuum bottle (thermos), ice-cream makers, etc.	*Household Science*, pp. 45–46 *Principles of Science*, p. 368 *Household Science*, pp. 47–48 *Principles of Science II*, p. 370 *Household Science*, pp. 21–22
8.3 Describe how household products, devices and techniques are designed to increase or decrease heat flow for specific purposes.	• Discuss why the walls of ovens are insulated.	
8.4 Describe the potential dangers of heat transfer.	• Discuss materials in the household that are used to protect against heat transfer (e.g., oven mitts, ceramic or wood hot plate stands, insulation in walls of homes).	

CONCEPT 9: Many household substances require special care in their use and handling.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
9.1 Identify substances which have safety labelling.	• Collect labels of common household substances. Observe: a) safety precautions b) ask about the recovery techniques for problems or errors in handling found on the labels.	*Household Science*, p. 76–79
9.2 List reasons why reading instructions for safe handling is important.	• Invite a paramedic or fire chief to: a) explain the hazards of potentially dangerous products found in the household b) describe safe handling techniques and storage, proper disposal of empty containers and waste materials c) describe recovery techniques for problems or error in handling.	
9.3 Describe common recovery techniques for problems or errors in handling.	• Draw the common labels that identify dangerous substances. Ask partner to identify what each means. • What are the dangers of: a) battery acid b) turpentine. Discuss proper storage of these substances in the home (e.g. flammable products stored in furnace rooms and basements). • How can you protect yourself from these dangers: a) before an accident occurs b) after an accident occurs.	
9.4 List the potential dangers of mixing certain household products.	• Discuss hazards with mixing substances such as bleach and drain cleaners; acids and bases.	*Household Science*, p. 78
9.5 Describe how micro-organisms can have beneficial and harmful effects on food material in the home.	• What are micro-organisms? • How are microorganisms helpful to people? Make a list. • Ask whether microorganisms are harmful to people. • Determine the places where bacteria may be growing. • What are the effects of temperature on the growth of bacteria? What are three other conditions required for bacterial growth?	*Household Science*, pp. 79–86 *Applied Science I*, Unit 15 pp. 98–199 p. 100 *Household Science*, pp. 81–82
	• How does canning preserve food? • What ways can food get spoiled? • How can we help to prevent food poisoning? (form a set of guidelines for a chef, kitchen staff and your family members to follow).	*Household Science*, pp. 85–86 *Applied Science I*, Unit 18 pp.109–110

UNIT III: INVESTIGATING THE ENVIRONMENT

Overview

Students will identify a problem that arises from a selected environmental issue. They will investigate the problem, identify any technology relating to the problem, and suggest a process or action plan to deal with the selected environmental issue.

The emphasis of this unit is the nature of science.

SPECIFIC LEARNER EXPECTATIONS

Attitudes

The student will be encouraged to:

1. Appreciate the fragility of the biosphere.
2. Realize our inability to anticipate the environmental effects of our human activities.
3. Develop optimism with respect to man's ability to live in harmony with the environment.
4. Develop a sense of personal responsibility and empowerment in relation to environment issues.
5. Appreciate that the collective action of individuals can have significant impact.
6. Develop healthy skepticism in regards to technology as the ultimate solution to environmental issues.
7. Appreciate that environmental issues involve significant relationships among science, technology and society.

Skills

The student will demonstrate an ability to:

1. Identify a problem associated with an environmental issue.
2. Gather, organize and evaluate such information.
3. Clearly communicate the results of the investigation.
4. Apply resulting information to a personal and/or societal situation.

Concepts

Students will be expected to demonstrate an understanding that:

1. Humans have the ability to affect the quality of the environment.

   1.1 List technological developments that produce materials the ecosystem cannot recycle.
   1.2 Identify the relationship between densely populated areas and the production of wastes that exceed the environment's capacity to recycle.
   1.3 Describe how land use practices may result in major changes to the environment.
   1.4 Give examples of how technological and societal developments can improve the quality of the environment.

Students will be expected to demonstrate an understanding that:

2. Science and technology influence and are influenced by societal issues.

   2.1 Identify examples of how science and technology develop in response to societal needs.

   2.2 Describe how scientific and technological developments, while meeting human wants and needs, may create or intensify problems (e.g., pollution).

Students will be expected to demonstrate an understanding that:

3. The effects of science and technology on society and the environment are often unforeseen.

   3.1 Identify examples of the unforeseen consequences of science and technology (e.g., nuclear fission, automobiles, herbicides and pesticides).
   3.2 Identify and analyze the circumstances that led to unforeseen consequences in one particular case.
   3.3 Evaluate the societal impact of a developments in science and technology.

Students will be expected to demonstrate an understanding that:

4. Individuals can become involved in the resolution of ecological problems which arise

   4.1 Identify ways that society can impact on science and technology, exercising some degree of direction and control through political and consumer pressure (e.g., provision of fiscal and manpower resources legislation, enforcement petition, voting, demonstrations.)
   4.2 Identify the ways an individual, as a member of society, can provide a degree of direction and control for science and technology (letters to MP's, lobby groups, personal habits).

Students will be expected to demonstrate an understanding that:

5. The biosphere is a thin layer on the surface of the earth, able to support life.

   5.1 Identify the components of the biosphere that provide the essentials of life.

Students will be expected to demonstrate an understanding that:

6. A continuous supply of solar energy is essential to life.

   6.1 Describe how the flow of solar energy through the biosphere is non–cyclical..
   6.2 Explain how photosynthesis and respiration are involved in the energy conversions necesary for life.
   6.3 Trace energy transfer from one feeding level to another identifying loss of heat energy at each transfer.

Students will be expected to demonstrate an understanding that:

7. Life depends on recycling processes.

   7.1 Explain why biochemical cycles are necessary to recycle matter.
   7.2 Identify the role of decomposers in the recycling process.
   7.3 Specify how biodegradable materials reduce the impact of man–made products on the environment.

Students will be expected to demonstrate an understanding that:

8. An ecosystem is the interaction of a community with its physical environment.

   8.1 List the physical factors which limit population growth.
   8.2 Describe how interaction between organisms affects populations.
   8.3 Illustrate with at least one example the impact organisms have on the environment.

CONCEPT 1: Humans have the ability to affect the quality of the environment.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 List technological developments that produce materials the ecosystem cannot recycle.	• Cut pictures of renewable resources from old magazines. Explain how each one is considered a renewable resource. Do the same for non-renewable resources.	
1.2 Identify the relationship between densely populated areas and the production of wastes that exceed the environment's capacity to recycle.		
1.3 Describe how <u>land use practices</u> may result in major changes to the environment.	• Find a newspaper article that describes some ways in which people are changing their physical environment to suit their own needs and wants, e.g., building a dam, or pulp-and-paper mill.	*Investigating the Environment*, pp. 61–71, 5–11 *Science at Work Plant Science*, pp. 30–31
1.4 Give examples of how technological and societal developments can improve the quality of the environment	• Discuss the advantages and disadvantages of birth control in third-world countries. • Give examples of various technology used in third-world countries in order to increase food production.	

CONCEPT 2: Science and technology influence and are influenced by societal issues.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Give examples of how science and technology develop in response to societal needs.	• Take a field trip to a local water treatment plant. Find out what is contained in safe drinking water (government pamphlet). • Investigate the causes of <u>air</u> and <u>sound</u> pollution.	*Science at Work Pollution*, pp. 1–16 *Investigating the Environment*, pp. 5–7, pp. 61–67 *Science at Work Pollution*, pp. 20–27, pp. 28–32
2.2 Describe how scientific and technological developments, while meeting human wants and needs, may create or intensify problems (e.g., pollution).	• How can we derive copper metal from copper ore? Do pollutants result? • Phone the government sanitation department and ask what the process for garbage disposal is. Has the ammount of garbage increased over the past 5 years to 10 years? Has the <u>type</u> of garbage changed? • Write a creative piece of work depicting how technology can effect the environment. (e.g., design a poster, poem, story, song, play, or commercial.)	*Investigating the Environment*, pp. 7–10

CONCEPT 3: The effects of science and technology on society and the environment are often unforeseen.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Identify examples of the unforeseen consequences of science and technology (e.g., nuclear fission, automobiles, herbicides and pesticides).	• Investigate local environmental concerns by following articles in the local newspapers (case study). Develop a scrapbook illustrating the events – see Teaching Strategies section.	*Investigating the Environment*, pp. 11–15
3.2 Identify and analyse the circumstances that led to unforeseen consequences in one particular case.	• Choose articles from science magazines about an <u>issue</u> and design questions on the information given. Use the SQ3R method (survey, question, read, recite and review – see Teaching Strategies section).	
3.3 Evaluate the societal impact of a development in science and technology.	• Discuss the efficiency of different types of farm equipment. • Trace the changes that have occurred in the use of energy from the horse to gasoline powered engines and from candlelight to nuclear energy. List the problems which came about due to new technologies.	

CONCEPT 4: Individuals can become involved in the resolution of ecological problems which arise.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Identify ways that society can impact on science and technology, exercising some degree of direction and control through political and consumer pressure (e.g., provision of resources – legislation, enforcement, petition, voting, demonstration) .	• Find out what steps are involved in changing legislation or by–laws in your community (e.g. increasing the fine for littering; or instating recycling procedures). • Find out who the political candidate is in your community. Ask what their intentions are concerning environmental issues.	
4.2 Identify the ways an individual, as a member of society, can provide a degree of direction and control for science and technology (letters to M.P.'s, lobby groups, personal habits).	• Write a letter to your MP addressing your concern pertaining to an environmental issue faced by your community (e.g., construction of a pulp and paper mill, or a waste disposal system). • Make a list of the number of ways you personally will support the betterment of our environment.	

CONCEPT 5: The biosphere is a thin layer on the surface of the earth able to support life.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
5.1 Identify the components of the biosphere that provide the essentials of life.	• Develop a classroom ecosystem and study its structure and function. (This may be done by collecting a pond water sample from a field or by placing sand in a large jar and adding a fish, and few plants and a snail.) a) observe samples of water b) identify organisms. • What is necessary to sustain life in a space capsule? • What are the effects of ultraviolet light on human skin? How can we protect ourselves? • Holes in the ozone layer are enlarging and therefore creating potential hazards to the biosphere.	*Alberta Environment on Water Quality.*

CONCEPT 6: A continuous supply of solar energy is essential to life.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
6.1 Describe how the flow of energy through the biosphere is non-cyclical.	• Explain the design of a pyramid of energy (loss of energy as you go up the pyramid). • Is the same amount of energy found at the top of the pyramid compared to the bottom?	*Investigating the Environment*, pp. 36–45
6.2 Explain how photosynthesis and respiration are involved in the energy conversions necessary for life.	• Discuss if light is necessary for starch formation in green leaves. • Examine the conversion of light energy to food during the process of photosynthesis. • Does photosynthesis produce oxygen gas? • Plants give off oxygen, which animals use. Suppose plants used more CO_2 and released more O_2 into the air, what would happen? Make oxygen–rich air and see. Note: The concept of "gases" may have to be developed first.	*Biology*, p. 172. *Biological Science*, p. 148. *Investigating the Environment*, pp. 29–32
6.3 Trace energy transfer from one feeding level to another identifying loss of heat energy at each transfer.	• Identify the pyramid (trophic) levels in either a classroom ecosystem or one in the local environment, e.g., the pond pyramid. • Diagram a biological food web or chain, using principal local plants and animals.	*Investigating the Environment*, p. 41 *Investigating the Environment*, pp. 33–35, 36–45

CONCEPT 7: Life depends on recycling processes.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
7.1 Explain why biochemical cycles are necessary to recycle matter.	• Describe the cycles involved in keeping the ecosystem functioning. (Note: if the above was not done in #1(a) have students identify the physical factors required in an ecosystem in order for animals and plants to survive.) – oxygen cycle (photosynthesis activities) – carbon cycle (sulphur dioxide and plants) – water cycle (acid rain activity) • Three main nutrients plants need are nitrogen, phosphate and potash. Test soils for nitrogen content. (i) the artificial process for changing nitrogen into ammonia (NH_3) can be done in the lab. Find out what nutrients are found in commercial fertilizer.	*Investigating the Environment*, pp. 27–29, 46–53 *Applied Science I*, pp. 56–64 *Science at Work Pollution*, p. 25. *Laboratory Biology*, p. 321 *Biology*, p. 179 *Science at Work: Plant Science*, pp. 2–17
7.2 Identify the role of decomposers in the recycling process.	• Identify the decomposers in a forest community. What is their purpose? • Show how bread decomposes.	*Investigating the Environment*, pp. 50–51
7.3 Describe how biodegradeable materials reduce the impact of man-made products on the environment.	• Cut pictures of biodegradeable substances from magazines. Identify the cycle involved in decomposition of these substances. Do the same for non-biodegradeable substances. • List ways used to dispose of waste. Call the City Works Department or local waste department.	*Investigating the Environment*, pp. 51–53 *Investigating the Environment*, p. 51

CONCEPT 8: An ecosystem is the interaction of a community with its physical environment.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
8.1 List the physical factors which limit population growth.	• Design an experiment to study the effects of various temperatures, amount of moisture, or amounts of light on seed germination. • Ask how crowding of plant seeds affects plant growth. • Using radish seeds, and three pots, plant a varying number of seeds (5, 15, 80) in each pot and observe over an 8–14 day period.	*Science at Work Plant Science*, p. 22.
8.2 Describe how interaction between organisms affects populations.	• What would happen if all the deer in a population were killed? • Give examples of how man has manipulated the environment to cause a change in the population.	*Investigating the Environment*, pp. 57–65
8.3 Illustrate with at least one example the impact organisms have on the environment.	• Describe the "forest" community. What relationships exist between the organisms? • A lumber company clears the forested region. Describe what will happen to: a) the existing community of plants and animals. b) the neighbouring community; i.e., What effects will the influx of new organisms have on this new community? • Choose an animal in your own environment and discuss the impact it has on the environment.	

UNIT IV: UNDERSTANDING THE TECHNOLOGY

Overview

Students will construct and/or manipulate and examine a simple device to determine the scientific principles upon which the operation of the device depends.

The emphasis of this unit is the nature of science.

SPECIFIC LEARNER EXPECTATIONS

*Note: This section incorporates the following topics.

1. Light
2. Sound
3. Machines
4. Electricity
5. Electricity–Electronics
6, Electric motors

No order is implied. Teacher's may wish to choose two of the above topics to concentrate on, or may wish to do a few activities from each topic.

Any combination is possible as long as science and technology is emphasized.

Attitudes

The student will be encouraged to:

1. Develop a positive attitude toward scientific and technological processes and skills.
2. Appreciate that in solving problems scientifically, new technologies develop.
3. Develop an awareness that science may involve technology and technology involves science.
4. Appreciate the importance of evaluating the design of a given technological device.
5. Appreciate the relationships among science, technology, and society.

Skills

The student will demonstrate an ability to:

1. Select and observe natural phenomena.
2. Select a current technology and identify the specific interrelationships that exist between science and technology.
3. Construct or acquire at least one simple device.
4. Test the operation of the device.
5. Evaluate the performance of the device.
6. Identify the scientific principles utilized by the device.
7. Identify a need or want not currently satisfied by a modern technology.
8. Create an original design for one of the above needs or wants.
9. Communicate how a specific technology has personal application.

<u>Concepts</u>

The student will be expected to demonstrate an understanding that:

1. **Science is the study of natural phenomena.**

    1.1 Illustrate with at least one example how observation of natural phenomena can lead to scientific inquiry.
    1.2 Specify, using at least one example, how scientific principles stem from scientific inquiry.

    The student will be expected to demonstrate an understanding that:

2. **Science is founded on facts, laws, and theories.**

    2.1 Differentiate among the terms <u>fact</u>, <u>law</u>, and <u>theory</u>.
    2.2 Identify the relevant scientific facts, laws and theories associated with the use of a simple device or observable phenomena.

The student will be expected to demonstrate an understanding that:

3. **Science can be used to advance technology and technology can be used to advance science.**

    3.1 Identify situations where science leads to advances in technology.
    3.2 Identify situations where technology leads to advances in science.

    The student will be expected to demonstrate an understanding that:

4. **People create technological devices and systems to satisfy needs and wants.**

    4.1 Illustrate with at least one example the application of the scientific principles in the development of modern devices.
    4.2 Identify a variety of human needs and wants, and list the technological devices developed to meet these needs and wants.

CONCEPT 1: Science is the study of natural phenomena. (LIGHT)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 Illustrate how observation of natural phenomena can lead to scientific inquiry.	PHENOMENA DEFINED: Facts, events or circumstances that can be observed: *Lightning is an electrical phenomena. Fever and inflammation are phenomena of disease.* • Light is an observable phenomena.	*Gage Canadian Dictionary*
1.2 Specify, using at least one example, how scientific principles stem from scientific inquiry.	• Light is a wave. Tie a rope to a doorknob, shake the loose end so waves are produced in the rope. Make a diagram of the waves. Which way does the rope vibrate? Show the direction the wave travels. • Light, although a wave, travels in "packages" called photons. Photons can create a tiny electric current. Photoelectric cells are used in electric eyes, light meters, and some cameras. A photocell contains a photoelectric metal which produces an electric current when struck by light. a) use light meters, photocells and human sight to see that light may generate a current picked up by the photocell and measured by the light meter b) research information on photon torpedos (like laser bursts); also, find out the specific eye protection used for arc welding c) measure the amount of current produced by light bulbs, window light and fluorescent tubes. • Light travels in straight lines. a) This may be investigated by using a Pinhole Camera to take a picture. b) Observe the beam of light of a movie projector or laser.	*Science, Technology and You*, p. 29 *Science, Technology and You*, pp. 30–32 *Science at Work: Photography*, pp. 5–8

CONCEPT 1 (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.2 Specify, using at least one example, how scientific principles stem from scientific inquiry.	• Refraction: when light travels from water to air, it bends away from the normal.	*Invitations to Science Inquiry*, p. 234
	Demonstrate by putting a pencil or ruler into a cup of water resting on the side of the cup. What do you see?	*Invitations to Science Inquiry*, p. 234 *Physics: A Practical Approach*, p. 397
	• Light travels in a straight line. However, the lines are refracted as they pass through a curved piece of transparent material; like a lens (a curved piece of glass).	*Physics: A Practical Approach*, p. 395
	• Lenses work together to produce effects.	
	Show how a waterdrop imitates a lens and thus is used as a magnifier: – Put a waterdrop on wax paper. The waterdrop resembles the shape of a magnifying glass. Place the wax paper with waterdrop over print and observe.	*Invitations to Science Inquiry*, p. 232
	• Label a diagram of a camera and the human eye shown side-by-side for comparative purposes.	*Physics: A Practical Approach*, pp. 412–413
	• Make a model of the human eye. a) Students can learn the parts of the eye easily when a model is built. Use a transparent balloon for the eyeball, white bristle board for the sclera, coloured paper for the iris, a convex lens for the lens, and a watch glass which represents the cornea. – Tape the convex lens to the coloured construction disk (ring structure). Place the coloured ring within the watchglass and fasten with tape. It may be helpful to make a single cut halfway across the paper disk to allow it to lie flat inside the watch glass. This structure is then fastened to a balloon blown up to about a 15 cm diametre. – If the ballon is transparent enough it can be used to form an image.	

CONCEPT 1 (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.2 Specify, using at least one example, how scientific principles stem from scientific inquiry.	<u>Note</u>: 1) Extension activities may include finding out how eye disorders such as nearsightedness and farsightedness are corrected. 2) Research how modern medicine and technology have been used in eye surgery. 3) Developing film in photography is based on the use of chemical and some scientific principles. Develop pictures taken from your camera. 4) Find out how a polaroid camera functions. 5) Label a simple diagram of an <u>electron microscope</u>: How does it compare and contrast to a <u>light microscope</u>? Show the lenses in both diagrams (Note: only simple diagrams are necessary here.) 6) What is holography? What property of light does it use to function?	*Science at Work: Photography*, pp. 18–22

CONCEPT 2: Science is found on facts, laws and theories.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Differentiate among the terms fact, law and theory.	• Definition of terms: *Note: The following definitions are useful for this unit: Fact: Something demonstrated to be true (objectively verified). Law: A generalization based on observed recurrence, order, relationship, or interaction of natural phenomena. Theory: Systematically organized knowledge applicable in a relatively wide variety of circumstances; especially, a system of assumptions, accepted principles, and rules of procedure devised to analyse, predict or otherwise explain the nature or behaviour of a specified set of phenomena.	*Houghton Mifflin Canadian Dictionary of the English Language* *Science, Technology and You*, pp. 12–16
2.2 Identify the relevant scientific facts, laws and theories associated with the use of a simple device or observable phenomena.	• Light obeys laws: when light reflects from any surface, it obeys the Laws of Reflection. Mirrors are used every day for many reasons. We can see ourselves, and they are used to help improve our vision when driving a) Observe images in a mirror in several ways e.g., use a mirror to decipher a message written upside down and backwards. Write a word using a mirror. b) Where is the image? Set up a mirror with a candle in front of it. An image in a mirror appears to be as far behind the mirror as the object in front of the mirror.	*Physics: A Practical Approach*, pp. 379–381 *Invitations to Science Inquiry*, p. 225

CONCEPT 2: (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.2 Identify the relevant scientific facts, laws and theories associated with the use of a simple device or observable phenomena.	• Curved Mirrors: a) concave mirror: has a reflecting surface that curves inwards. Examples: – car headlight – concentrated sunlight as in a solar cooker – reflecting telescope.	 *Physics: A Practical Approach*, pp. 390–391
	b) convex mirror: has a reflecting surface that bulges outwards, making it possible to see over a wide angle.	*Science, Technology, and You*, p. 35
	• Using convex lenses will demonstrate how pioneers like Galileo invented optical instruments. a) using two converging lenses, find the focal length of the lens. b) use a convex lens to magnify print: – this illustrates an optical device, called a magnifier or a simple microscope – magnify insects, a dollar bill, and a stamp using the lens (magnifying glass). What happens if you put one magnifying glass on top of another?	*Physics: A Practical Approach*, pp. 391, 417–420

CONCEPT 3: Science can be used to advance technology and technology can be used to advance science.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Identify situations where science leads to advances in technology.	• Applications of plane mirrors: have students list these. a) Plane mirrors are used in looking glasses: What do you see in the mirror when you touch your left ear? b) Used in arcade shooting galleries c) The kaleidoscope: have students look through one. The multiple images seen are due to two plane mirrors being placed at an angle to each other. • What type of mirrors are used in the following: a) Stores b) Rear-view mirrors on vehicles	*Physics: A Practical Approach*, pp. 382–383
3.2 Identify situations where technology leads to advances in science.	• Lasers: American physicist Theodore H. Maiman, toward end of 1960, made a dramatic breakthrough in the Technology of Light. Along with Charles H. Tounes, Maiman built the first laser—an instrument capable of producing a thin pencil of ultra-intense light. a) Draw a picture of a laser and label the parts it needs in order to function. b) List the applications of the laser in medicine, industry and in the military.	*Science, Technology, and You*, pp. 65–66

CONCEPT 4: People create technological devices and systems to satisfy needs and wants.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Illustrate with at least one example the application of scientific principles in the development of modern devices.	• Set up two lenses and observe print. This demonstrates the principles of a simple compound microscope. a) Label a simplified diagram of a microscope b) Using a compound microscope, observe the letter "e." Determine two important properties of a compound microscope c) Note the importance of the iris diaphragm, mirror and lenses in the microscope (this will be used later in a comparison with the camera and human eye).	*Applied Science*, p. 123
4.2 Identify a variety of human needs and wants and list the technological devices developed to meet these needs and wants.	• A similar set-up of lens as above will demonstrate the properties of a <u>refracting telescope</u>. List the properties. – How are **binoculars** similar to yet different from a refracting telescope? • Make a simple slide projector to demonstrate another use of lenses. • Using a **lens** in a **pinhole camera**, take a picture and develop it. • Label a diagram of a modern camera – name the function of the aperture, shutter, lens, film, and focus setting	*Physics: A Practical Approach*, p. 417 *Science at Work: Photography*, p. 9 *Physics: A Practical Approach*, pp. 410–412

CONCEPT 1: Science is the study of natural phenomena (SOUND).

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 Illustrate with at least one example how observation of natural phenomena can lead to scientific inquiry.	PHENOMENA DEFINED Facts, events or circumstances that can be observed: *Lightning is an electrical phenomenon. Fever and inflammation are phenomena of disease.* • Sound can be heard when water falls, thunder claps, somebody sings. The energy that creates those sounds comes from vibrating objects. It travels through air or any medium capable of transmitting a vibration.	*Gage Canadian Dictionary* *Science, Technology and You*, pp. 37–40
1.2 Specify, using at least one example, how scientific principles stem from scientific inquiry.	a) Make a list of sound vibrations that can be seen; e.g., pluck a guitar string, strike a tuning fork. b) List sound vibrations that cannot be seen.	

CONCEPT 2: Science is founded on facts, laws and theories.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Differentiate the terms <u>fact</u>, <u>law</u>, and <u>theory</u>.	<u>PHENOMENA DEFINED</u> Facts, events or circumstances that can be observed: *Lightning is an electrical phenomena. Fever and inflammation are phenomena of disease.* • Definition of terms: 1. <u>Fact</u>: Something demonstrated to be true (objectively verified). 2. <u>Law</u>: A generalization based on observed recurrence, order, relationship, or interaction of natural phenomena. 3. <u>Theory</u>: Systematically organized knowledge applicable in a relatively wide variety of circumstances; especially, a system of assumptions, accepted principles, and rules of procedure devised to analyse, predict or otherwise explain the nature or behaviour of a specified set of phenomena.	*Gage Canadian Dictionary*
2.2 Identify the relevant scientific facts, laws and theories associated with the use of a simple device or observable phenomena.	*Note: <u>PHENOMENA DEFINED</u> Facts, events or circumstances that can be observed: *Lightning is an electrical phenomena. Fever and inflammation are phenomena of disease.* • Transmission of sound energy a) Demonstrate, by removing air with a vacuum pump, that a vibrating metal arm striking a metal sounder needs air in order for the sound to be heard. b) Check to see if the prongs of a tuning fork vibrate by placing the prongs in water. • Measuring the speed of sound Why do you hear thunder a few seconds after lightning strikes? Sound travels slowly and can be measured.	*Science, Technology and You*, pp. 37–44

CONCEPT 3: Science can be used to advance technology and technology can be used to advance science.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Identify situations where science leads to advances in technology.	• Ultrasonics a) Research the uses of ultrasonics and its impact on society. b) What is sonar and on what principle was it developed? • Extension a) Measure different sound levels found in everyday life. b) What constitutes sound and noise? c) Look at the picture produced by an oscilloscope to see the different waves different sounds produce.	*Physics: A Practical Approach*, p. 239 *Physics: A Practical Approach*, p. 243–244

CONCEPT 4: People create technological devices and systems to satisfy needs and wants.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Illustrate with at least one example the application of the scientific principles in the development of modern devices.	• Make your own instrument and explain how it produces sound. a) Put water in a pop bottle, then blow into it. Try changing the level of water in the bottle. b) Put rubber bands, one thick and one thin, around a ruler, insert a pencil and comment on how the thickness affects the sound. c) Could this be turned into an electrical instrument?	*Invitations to Science Inquiry*, pp. 243–244, 246, 247
4.2 Identify a variety of human needs and wants, and list the technological devices developed to meet these needs and wants.	• Examine the various sound systems being advertised. Make a list of features to look for when buying a good sound system. • Construct a speaker; explain the components required for its operation. • With modern technologies, development of speech recognition machines and the mechanical simulations of speech along with computers, it might be possible to dictate directly to a typewriter. • Make a simple telephone: two cans joined together by string. Test it by talking into it at a whisper and then into the air. Is there a difference? Explain why. Note: This section may overlap with other activities based on electronics. • Build a) A two-stage amplifier b) A telephone circuit	*Invitations to Science Inquiry*, p. 52 *Science, Technology, and You*, pp. 45–51 *Science at Work*, pp. 22–23

CONCEPT 1: Science is the study of natural phenomena (MACHINES).

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 Illustrate with at least one example how observation of natural phenomena can lead to scientific inquiry.	PHENOMENA DEFINED: Facts, events or circumstances that can be observed: *Lightning is an electrical phenomena. Fever and inflammation are phenomena of disease.* **Lever Family** • What is a lever? How are the three classes of levers the same and how are they different? • Have an array of tools to do this exercise (e.g., crowbar, spanner, wrench, nutcracker, scissors, pliers, tongs, hammer and tweezers). a) What is the function of these tools? b) What do they have in common? c) How do they help man?	*Gage Canadian Dictionary* *Physics: A Practical Approach*, pp. 142–143 pp. 140–144 *Science, Technology and You*, p. 20
1.2 Specify, using at least one example, how scientific principles stem from scientific inquiry.	• Find out from research what simple devices/machines were used for tools, weapons, building and everyday use. • The inclined–plane family Show how an inclined plane can be used to minimize effort to load heavy objects to a higher place. a) carry a large drum from the floor to the table b) make a ramp with a board resting on the table and roll the drum up the ramp c) which method was easier? • Have students find out which requires more effort to move two weights (e.g., 100g and 200g), by moving the 100g weight straight up or the 200g weight using an incline (made by resting a ruler on a stack of books).	*Applied Science*, p. 20 *Science, Technology and You*, pp. 18–21

CONCEPT 2: Science is founded on facts, laws and theories.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Differentiate among the terms <u>fact</u>, <u>law</u> and <u>theory</u>.	• Definition of terms: 1. <u>Fact</u>: Something demonstrated to be true (objectively verified). 2. <u>Law</u>: A generalization based on observed recurrence, order, relationship, or interaction of natural phenomena. 3. <u>Theory</u>: Systematically organized knowledge applicable in a relatively wide variety of circumstances; especially, a system of assumptions, accepted principles, and rules of procedure devised to analyse, predict or otherwise explain the nature or behaviour of a specified set of phenomena.	*Houghton Mifflin Canadian Dictionary of the English Language*
2.2 Identify the relevant scientific facts, laws and theories associated with the use of a simple device or observable phenomena.	• Do an activity to demonstrate how a heavy load can be lifted with one finger Students can try to lift one side of a heavy piece of furniture to give them an idea of its weight. Place blocks on the side of the table to be lifted, and place the end of a long stick under the table rung—use the blocks as a fulcrum for the lever. Push the stick down and observe. Have students try to explain how this was accomplished. • Explain how a teeter-totter (see-saw) works. • Draw a <u>wheel and axle</u>. Explain why it is considered similar to a lever. • <u>Enrichment and Extension</u> Mechanical advantage of <u>machines</u>. A main function of machines is to change the force applied to the load – explain the concept of <u>Newton</u> as a unit of measurement before using the formula.	*Invitations to Science Inquiry*, p. 279 *Applied Science*, p. 21

CONCEPT 2: (continued)

SUB–CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.2 Identify the relevant scientific facts, laws and theories associated with the use of a simple device or observable phenomena.	Calculate the mechanical advantage (MA) of a pulley or a screwdriver to open a paint can by using the following formula: $MA = \frac{\text{Load (force in Newtons)}}{\text{Effort (force in Newtons)}}$ e.g., What is the (MA) of a screwdriver if a 20 N effort force exerted a 140 N load force. $MA = \frac{F(L)}{F(E)}$ $MA = \frac{140(N)}{20N}$ $MA = 7N$	*Physics: A Practical Approach*, p. 151

CONCEPT 2 (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Realize that scientific principles arise from scientific process.	<u>The inclined-plane family</u> Show how an inclined plane can be used to minimize effort to load heavy objects to a higher place a) carry a large drum from the floor to the table b) make a ramp with a board resting on the table and roll the drum up the ramp c) which method was easier? • Have students find out which requires more effort to move two weights (e.g., 100g and 200g), by moving the 100g weight straight up or the 200g weight using an incline (made by resting a ruler on a stack of books).	*Applied Science*, p. 20

CONCEPT 3: Science can be used to advance technology and technology can be used to advance science.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Identify situations where science leads to advances in technology.	• List the ways in which pulleys have been used. • The wedge, screw, a "dolly"and chisel are other applications of the inclined plane. Students should list how they are used as simple machines. (e.g., a screwdriver is used to open a paint can) • Observe the chain drives in: a) a bicycle b) a motorcycle	*Physcis: A Practical Approach*, pp.140–155 *Science, Technology and You*, p. 22 pp. 18–23 *Science at Work: Gears & Gearing*, pp. 1–3

CONCEPT 4: People create technological devices and systems to satisfy needs and wants.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Illustrate with at least one example the application of the scientific principles in the development of modern devices.	• Is the hammer a lever? Try pulling out the nails from a board by pulling down on the hammer, and label a diagram showing the fulcrum, effort and resistance. • Apply this to the use of a <u>system</u> of pulleys to move a load. Use the same weight using a single movable pulley and then use two or three pulleys to do the job. • <u>Complex machines</u>: A complex machine is a device made of two or more simple machines, used to increase the mechanical advantage of each simple machine. Analyse a complex machine in detail (e.g., a crane used in construction, a pencil sharpener, a typewriter, a heavy engine hoist). • Give examples of machines (simple or complex) that fulfill the following functions: a) Change energy from one form to another (hydroelectric generator) b) Change the direction of a force (pulley) c) Increase or decrease force (heavy engine hoist) d) Increase or decrease distance (bicycle) e) Transfer energy from one place to another (can transfer energy from the motor to the wheels). • List several advantages and disadvantages of using machines in our society. • You are moving to another planet (similar to earth) only you cannot take all the machines with you. Which machines in today's society would you select? Why? Create the ultimate machine to take with you; e.g., The Swiss army knife. • Look at a diagram of the muscular and skeletal systems of the human body. devise a model to represent the bicep muscle and how it works to lift a load.	*Invitations to Science Inquiry*, p. 280 *Applied Science*, p. 22 *Physics: A Practical Approach*, p. 156 *Invitations to Science Inquiry*, p. 281

CONCEPT 4 (continued)

SUB–CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.2 Identify a variety of human needs and wants, and list the technological devices developed to meet these needs and wants.	**<u>Pulley:</u>** • A pulley is another kind of first–order lever. Give the students a piece of rope, a brick and a pulley. They have to move the brick from the floor to the table. Have them devise a method of lifting the weight, using the apparatus. Simple mathematical problems may be done to apply the <u>law of levers</u>. It can be used to determine the <u>effort force</u> needed to balance or slowly lift <u>a known load</u>. **<u>Belts, Chains, and Gears:</u>** a) Make a belt drive and find out how it works in transferring power b) Make a chain drive and find out how it works c) Design and make a chain–driven vehicle <u>Extension</u>: 1) Find out how gears work and demonstrate some common gears. 2) Design and build a vehicle (model size) with a steering wheel that turns the front wheels. 3) If your school has an automotives shop ask to observe the gearbox from a car. Work out how gears help us to drive.	*Applied Science*, pp. 21–23 *Science, Technology and You*, p. 22 *Physics: A Practical Approach*, p. 141, 149, 155 Physics, A Practical Approach, pp. 151–153 *Science at Work: Gears and Gearing*, pp. 4–15 *Applied Science*, p. 24 *Science at Work: Gears and Gearing*

CONCEPT 1: Science is the study of why natural things happen the way they do.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 Illustrate with at least one example how observation of natural phenomena can lead to scientific inquiry.	*Note: PHENOMENA DEFINED: Facts, events or circumstances that can be observed: *Lightning is an electrical phenomena. Fever and inflammation are phenomena of disease.* • Observe the forces that attract tiny pieces of paper to a comb after a comb has been run through the hair. • What happens if you rub your feet while walking on a rug, and then touch someone or a doorknob? • Observe a bolt of lightning during a thunderstorm or look at a picture of one. • Read about the works of Benjamin Franklin and other noted scientists and their work involving electricity.	*Gage Canadian Dictionary* *Principles of Science II*, pp. 413–416 *Invitations to Science Inquiry*, pp. 193, 199–201 *Science, Technology and You*, p. 25
1.2 Specify, using at least one example, how scientific principles stem from scientific inquiry.	Electromagnetism: This is the action involving both magnetism and electricity discovered by British physicist Michael Faraday. Faraday found that a current traveling through a wire produces a magnetic field. • Demonstrate the laws of magnetism, using two magnets. **Electric Current:** a) Use the analogy of water flowing through a pipe to electricity flowing through a wire. b) Measure current and voltage from different incandescent light bulbs.	*Science, Technology and You*, pp. 57–58 p. 42 *Principles of Science II*, pp. 411–412 *Science, Technology and You*, pp. 53–55 *Science, Technology and You*, pp. 32–33 *Science, Technology and You*, pp. 30–36 *Principles of Science II*, p. 416

CONCEPT 2: Science is founded on facts, laws and theories.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Differentiate among the terms fact, law and theory.	• Definition of terms: 1. Fact: Something demonstrated to be true (objectively verified). 2. Law: A generalization based on observed recurrence, order, relationship, or interaction of natural phenomena. 3. Theory: Systematically organized knowledge applicable in a relatively wide variety of circumstances; especially, a system of assumptions, accepted principles, and rules of procedure devised to analyse, predict or otherwise explain the nature or behaviour of a specified set of phenomena.	*Houghton Mifflin Canadian Dictionary of the English Language*
2.2 Identify the relevant facts, laws and theories associated with the use of a simple device or observable phenomena.	• Prove the laws of repulsion and attraction in static electricity. This may be done in a number of ways (e.g., charge a plastic pen by rubbing it with wool or fur. Use the rod to charge the two pith balls by touching the rod to the two pith balls. Do they attract or repel when charged?) Note: A glass and rubber rod can also be used. The laws of static electricity may be called the law of repulsion and the law of attraction. Repulsion means repelling or pushing apart. Attraction is the opposite—it means pulling together. Both the pushing and pulling result from the force of electricity. • Electric current is a measure of how many electrons pass through a wire or other electric device each second. An instrument used to measure electric current is called an AMMETER – Measure electric current (amperes)	*Science, Technology, and You*, pp. 25–27 *Physics: A Practical Approach*, p. 277 *Principles of Science II*, pp. 427–428 *Science, Technology, and You*, p. 34 *Physics: A Practical Approach*, p. 298

CONCEPT 2: (continued)

SUB–CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.2 Identify the relevant facts, laws and theories associated with the use of a simple device or observable phenomena.	• The source of electric current gives energy to the electrons it sends out. Electric voltage rise is a measure of the amount of energy given to a group of electrons that leave the source. An instrument used to measure electric voltage is called a VOLTMETER (Compare this once again to the analogy of water in a pipe and electricity in a wire.	*Physics: A Practical Approach*, p. 300 *Science, Technology, and You*, pp. 30–36
	Measure voltage (voltage).	
	• Draw a simple circuit diagram.	*Principles of Science II*, pp. 417–423
	• Identify common circuit symbols.	*Science at Work: Domestic Electricity*, p. 4
	• A number of activities on household power circuits can be done.	*Science at Work: Domestic Electricity*, pp. 17–23
	Find out how electrical energy is delivered to homes.	*Applied Science I*, pp. 82–83
	• Demonstrate the laws of magnetism, using two magnets.	*Physics: A Practical Approach*, p. 330 *Science, Technology and You*, pp. 53–56
	• Using iron filings and a bar magnet, observe and draw the magnetic field produced around a bar magnet.	*Principles of Science II*, pp. 409–411
	• Make an electromagnet from a large nail, bell wire, a 6v battery; test it by using it to pick up paper clips.	*Science, Technology, and You*, pp. 56–59
	Determine how its strength is affected by the current and number of windings.	

CONCEPT 3: Science can be used to advance technology and technology can be used to advance science.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Identify situations where science leads to advances in technology.	**Conductors: Insulators**	*Science, Technology and You*, pp. 32–33
	• A material whose electrons do not travel easily is called an electrical insulator. The opposite kind of material, an electrical conductor, allows the transfer of electrons easily.	
	a) Test the substances by using an electroscope to determine whether it is a conductor or insulator. (Note: an electroscope is a device, such as a plastic rod, that can be used to store a known charge.)	*Physics: A Practical Approach*, pp. 280–285
	b) Make a list of good conductors and insulators. (Note: metals are good electrical conductors.)	
	• Explain the principle of a lightning rod, and/or a static pad under a computer.	*Principles of Science II*, p. 415
	• A common type of static-electricity generator is called the Van de Graaff generator. It may be used to demonstrate many phenomena in static electricity. (Note: If not available at a school, visit a university, college, or science centre for a demonstration.)	
	• List ways that static electricity is a nuisance.	
	• Find out what a negative-ion generator is.	
	• List some applications of static electricity.	*Physics: A Practical Approach*, p. 290
	Electromagnetism: Applications	
	• Early Application:	
	– Telegraph: A communication system that transmits and receives simple electric impulses by wires. Morse code was sent over long distances.	*Science at Work: Technology Telecommunications*, pp. 13–16
	• Set up a simple telegraph system, using the principles of electromagnetism. This can be done using a simple switch, nail, and bell wire; a battery (6volt) and bulb and holder, a small block of wood, strip of tin, and small screw.	*Invitations to Science Inquiry*, p. 221 *Science at Work: Technology Telecommunications*, pp. 13–14

CONCEPT 3 (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.2 Identify situations where techology leads to advances in science.	**Car Electricity** • List all the jobs that electricity does in a car. – illuminate the lights – operate the stereo or tape deck – operate the windshield wipers – allow the heater or air conditioner fan to run – heat the defroster wire – sound the horn – start the car – ignite the gas – air mixture in the cylinders – allow the automatic components – windows, seats, etc. – to work. • What three things are necessary for electricity to do various jobs in a car? – a battery or generator as the source of electricity – a circuit of electricity – some way of turning it on and off.	*Science at Work: Science and the Motor Car*, pp. 13–16
	• Most cars have a lead-acid battery. It supplies electricity to the starter motor and, at first, to the spark plugs that ignite the gasoline. A battery has cells. When the battery supplies electricity to some things such as the starter motor, a chemical reaction takes place. a) Demonstrate how one of these cells works.	*Science at Work: Science and the Motor Car*, pp. 11–12
	b) Show how you can get electricity from a lemon, using zinc and copper strips, wire lead and a galvanometer or an 0.2 volt bulb. Can you use other metals to make electricity with the lemon? What other fruits can be used instead of the lemon? • Make a drawing of a flashlight; label parts and explain how it functions. Note: Car electricity may overlap into Science 24 Unit II, Energy Consumption; details may be covered at that ime.	*Invitations to Science Inquiry*, p. 215

CONCEPT 3 (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.2 Identify situations where techology leads to advances in science.	**Uses of Current Electricity** • Electricity provides comfort, convenience, entertainment and does a great amount of work for us. Note: Unit II: Energy Consumption deals with the conversion of chemical, heat and light and mechanical energy into electrical energy. Once the electrical energy is used, it can be changed back into other types of energy. • List household appliances that change electrical energy into a) heat b) light c) mechanical energy, and list their uses.	*Physics: A Practical Approach*, pp. 318–319

CONCEPT 4: People create technological devices and systems to satisfy needs and wants.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Illustrate with at least one example the application of scientific principles in the development of modern devices.	**Uses of Current Electricity:** • Take apart an old toaster and examine the parts and circuit. Illustrate what is seen, and label appropriately. • <u>Note</u>: If the nervous system was covered in Science 14, Unit I, Body Systems, the human body's own electrical system can be discussed. a) Application of electrical activity in medicine has aided patients with bone fractures. b) Explain the electric device called a pacemaker. c) Have an electrocardiogram (ECG) demonstrated at the lab or hospital and explain the basics of the electrical activity of the heart and how the machine functions. **Modern Devices** • Make an electric buzzer or bell and find out how it works. • Explain how an electromagnetic lift is designed. Are there any other technologies learned previously that are also used in its design? • Find out how a tape recorder works. • Make a microphone.	*Principles of Science II*, p. 412 *Science at Work: Domestic Electricity*, pp. 24–26 *Science at Work: Technology Telecommunications* p. 18

CONCEPT 3: Science can be used to advance technology and technology can be used to advance science.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Identify situations where science leads to advances in technology.	**Lamps and Resistors:** ● Variable resistors are used in radios and stereo sets to control the volume, and in a T.V. set to control the brightness of the set. How does a resistor work?	 *Science at Work: Electronics*, pp. 1–7
3.2 Identify situations where technology leads to advances in science.	● The transistor was a major breakthrough in electronics. What does a transistor do? ● Build a simple amplifier. What are the advantages of an amplifier? ● Build a two-stage amplifier. ● Make a telephone circuit. ● Build a simple radio receiver. ● Make a radio. ● Research the old crystal radio sets. (Note: crystal radio kits may be bought and assembled.) ● Improve the radio receiver by adding the single-stage amplifier. ● Extension Activities: a) build a light-sensitive circuit. b) build a frost, steam, or rain alarm.	*Science at Work: Electronics* pp. 12–14 *Science at Work: Electronics*, pp. 21–22 p. 22 p. 23 p 24 *Science at Work: Technology, Telecommunications*, p. 23–26 *Science at Work: Electronics*, p. 25, 28 *Science at Work: Electronics* p. 15 pp. 17–20

CONCEPT 4: People create technological devices and systems to satisfy needs and wants.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Illustrate with at least one example the application of the scientific principles of modern devices.	• Electronics is the branch of science and engineering concerned with the understanding, development and applications of electronic devices. (*How it Works Encyclopedia*) • Electronic Devices: An electrical circuit is designed to control electric current for a particular purpose and consists of components, or elements, with specific electrical characteristics. • Cut out magazine pictures to describe your ideas of electronics. Students should make up their own definitions of electronics after this exercise. • Take apart an old transistor radio and identify the parts.	
	• Look at a computer "chip" and observe the complex network of circuits in a computer system by observing diagrams.	*Science, Technology and You*, pp. 8–9
	• Discuss the various functions of computers in our society today.	
	• Think of something that a computer has not been used for. • Enrichment/Extension: (due to lack of written material for hands-on activities, these sections may be covered by any research technique – See Teaching Strategies Section). 1. What is a semiconductor? 2. Electronics have been used widely in medicine. Research the uses; e.g., ultrasonic equipment: oscilloscopes, electroencephalographs (for brain waves), ECG (electrocardiographs), monitoring system, computers.	*Science at Work: Technology: Computers and Computing*, p. 32

CONCEPT 4: (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Illustrate with at least one example the application of the scientific principles of modern devices.	3. Science at Work Modules contain enrichment activities. They can be used as project ideas or for those students that are faster workers, for bonus credit.	
	Suggested Activities	
	a) Build your own Robot Arm.	*Science at Work: Technology Microcomputers in Control*, pp. 1–20
	b) Build a candy-dispensing machine from interlocking building blocks.	*Science at Work: Technology: Microelectronics in Control* pp. 1–18
	c) Design and build a model car with an interlocking building block kit (e.g., Lego).	*Science at Work: Technology: Electronics in Control*, pp. 5–7
	d) Electronic Control Systems: Sensors	pp. 8–15
	e) A closer look at Computers: –simulations –graphics –sound	*Science at Work: Technology: Computers and Computing*
	f) Communication using optical fibres.	*Science at Work; Technology: Telecommunications*, pp. 27–32

CONCEPT 1: Science is the study of why natural things happen the way they do.

SUB–CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.2 Specify, using at least one example, how scientific principles stem from scientific inquiry.	• The English scientist Michael Faraday (1791–1867) discovered that the magnetic force from a permanent magnet can interact with the magnetic force form an electron–carrying conductor. This discovery is referred to as the <u>motor principle</u>.	*Physics: A Practical Approach*, p. 342 *Principles of Science II*, p. 412

CONCEPT 2: Science is founded on facts, laws and theories.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Differentiate fact, law, and theory.	Fact: Something demonstrated to be true (objectively verified). Law: A generalization based on observed recurrence, order, relationship, or interaction of natural phenomena. Theory: Systematically organized knowledge applicable in a relatively wide variety of circumstances; especially, a system of assumptions, accepted principles, and rules of procedure devised to analyse, predict or otherwise explain the nature or behaviour of a specified set of phenomena.	
b.	• An electric motor is a device that changes electrical energy into mechanical energy. • List the two main parts of a motor. • Using diagrams, step by step, the motor principle can be demonstrated. • Make or obtain a St. Louis motor, identify the parts.	*Physics: A Practical Approach*, pp. 346–347

CONCEPT 4: People create technological devices and systems to satisfy needs and wants.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Illustrate, using at least one example, the application of the scientific principles of modern devices.	• An electric motor is a device that changes electrical energy into mechanical energy. • List the two main parts of a motor. • Using diagrams, step by step, the motor principle can be demonstrated. • Make or obtain a st. Louis motor, identify the parts.	*Principles of Science II*, pp. 411–412 *Physics: A Practical Approach*, pp. 346–347
4.2 Identify a variety of human needs and wants, and list the technological devices developed to meet these needs and wants.	• List some applications of motors that we could now consider a necessity. a) list motorized products that we could probably do without b) list all the motorized products that are used through the course of a day. • Find out the principles behind the functioning of an electrical generator. Write to a hydro–electric generating plant for brochures and information. • Take apart an old hair dryer. Look at the parts and identify the principles that are behind the operation of the device. • Identify a need or want not currently satisfied by a modern technology. Create an original design for one of the above needs or wants. Example: An energy–efficient snowpedmobile.. Note: a) Listing examples may stifle the imagination of inventors. b) Students can perhaps combine two machines to improve the functions c) Robots to do specific functions could also be used (see enrichment activities under Electronics section). • Using meccano, lego or any other construction materials to construct a model (e.g., a peddle bike with rotating fan to keep cool, etc.). • Give students bags containing an array of materials; e.g., string, marbles, ruler, paper, wire, and ask them to design something.	 *Physics: A Practical Approach*, pp. 360–363

SCIENCE 24

SAMPLE ACTIVITIES

UNIT I: DISEASE DEFENCE

__Overview__

Students are to become aware of common diseases and their effect on our society. The technology involved in the study, treatment, and cure of these diseases will be investigated.

The human immune system, immunization, and current related biotechnology will be major areas of study.

The emphasis of this unit is the nature of science.

SPECIFIC LEARNER EXPECTATIONS

__Attitudes__

The student will be encouraged to:

1. Appreciate that in solving problems scientifically, new technologies often develop.
2. Appreciate that ethical dilemmas may arise from the application of scientific research and/or technological developments.
3. Appreciate the relationship among science, technology and society.
4. Develop a responsible attitude toward disease prevention.
5. Develop an awareness of the limits of science and technology in regard to control and cure of human disease.

__Skills__

Students will be expected to demonstrate the ability to:

1. Identify, use, and evaluate various methods of problem solving.
2. Apply data collection, organization, and interpretation skills.
3. Recognize the limits of science and technology.
4. Develop skill in the use of a light microscope/microslide viewer.
5. Observe and identify basic cell structures visible under the light microscope/microslide viewer.
6. Implement basic principles of disease prevention that contribute to human health.

__Concepts__

Students will be expected to demonstrate an understanding that:

1. **Diseases can be communicable or non-communicable.**

    1.1 Comprehend the historical base of the disease concept.
    1.2 Describe how communicable diseases are transmitted by microbes such as viruses, bacteria, protists and fungi.
    1.3 Describe how non-communicable diseases result from an interaction of variables (e.g., nutrition, compromised immune system, stress, heredity, alcohol, smoking.)
    1.4 Describe the steps that can be taken to reduce the risk of contracting disease.

Students will be expected to demonstrate an understanding that:

2. **The microscope is an essential tool for looking at microbes and cells.**

   2.1 Relate structure to function in a light microscope.
   2.2 Describe how the invention of the electron microscope, made possible the study of viruses and extremely small structures within the cell, which led to great advances in science.

Students will be expected to demonstrate an understanding that:

3. **The human body has natural systems of immunity.**

   3.1Describe how immunity can be achieved through contact with specific diseases.
   3.2 Know how antibodies and phagocytes function as major components of the body's defense/immune system.
   3.3 Explain that through placental transfer and breast milk the maternal system antibodies pass to the offspring, providing some degree of immunity to the child.
   3.4 Identify examples of abnormal immune responses (e.g., allergies, AIDS).

Students will be expected to demonstrate an understanding that:

4. **Biotechnical and biomedical processes have greatly enhanced our immune systems.**

   4.1 Explain why aspetic technique is critical to modern medical practice (historical development).
   4.2 Relate how artificial immunization (vaccines) prevents the contraction of many diseases.
   4.3 Describe how antibiotics suppress bacterial growth.
   4.4 Identify advances in genetic research which relate to disease defence (e.g., the splicing and cloning of genes to make antibionics).

Students will be expected to demonstrate an understanding that:

5. **Immunization technology is based on scientific principles.**

   5.1 Trace the historical development of immunization therapy (Jenner, Pasteur, Koch, Salk).
   5.2 Describe how the body recognizes a foreign substance (antigen) and can produce specific antibodies against it.
   5.3 Describe how immunity can be induced by injection with attenuated or killed micro-organisms (e.g., measles, mumps, polio, rabies).
   5.4 Outline how injection of antibodies directly into an individual results in passive immunity (e.g., tetanus, hepatitis).

Students will be expected to demonstrate an understanding that:

6. **Factors behind biotechnical and biomedical processes have societal implications.**

   6.1 Explain that vaccines provide immunity against diseases that were formerly fatal.
   6.2 Cite two examples of transplants or implants that may increase life expectancy.
   6.3 Identify and describe two techniques for genetic screening that make it powwible to detect genetically transmitted diseases and disorders.
   6.4 Describe the interaction of a biomedical process with science and society.
   6.5 Cite one example of scientific research into the diseases of domestic crop plants leading to the development of technology which allowed the production of disease-resistant strains.

CONCEPT 1: Diseases can be communicable or non-communicable.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 Trace the historical development of the disease concept.	• Simulate Louis Pasteur's experiment with swan-neck flasks, which shows the discovery of the effects of the micro-world. • Read "How Cholera Spreads," the work of John Snow. Trace the use of the scientific method. • Watch a film on poliomyelitis.	*Applied Science*, p. 96 *The Experience of Science*, p. 70
1.2 Describe how communicable diseases are transmitted by microbes such as bacteria and viruses, protista and fungi.	• Classify 10 common diseases into two headings: communicable and non-communicable. Check your classifications with a dictionary. • Review discussion: Disease prevention measures, such as washing, getting enough sleep, refrigerating food, cooking meat thoroughly and adding chlorine to drinking water. (Filmstrip introducing Microbes and Disease) • Lab: Grow microbes on agar to determine the places where microbes may grow. • What makes cheese go mouldy? • Grow bread mould and fruit mould. Observe under the microscope. • What types of bacteria cause food poisoning? What methods can be used to prevent food poisoning? • Using microslide viewers observe slides on bacteria, viruses and fungi. • Invite a health unit nurse or health inspector to talk about disease prevention and immunization.	*Disease Defense*, pp. 5–6 *Health*, Ch. 22, p. 435 *Visual Science Series, Microbes* *Principles of Science II*, p. 144 *Applied Science*, p. 96 *Disease Defense*, pp. 17–21 *Disease Defense*, p. 9
1.3 Describe how non-communicable diseases result from an interaction of variables (e.g., poor nutrition, compromised immune system, stress, heredity, alcohol, smoking).		*Health*, Ch. 22, p. 435 *Visual Science Series, Microbes* *Principles of Science II*, p. 125–141 p. 163–181

CONCEPT 1: Know how non-communicable diseases result from an interaction of variables (e.g., poor nutrition, compromised immune system, stress, heredity, alcohol, smoking).

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.3 Disease can be communicable or non-communicable. CANCER AND THE CELL a) What is cancer?	• Obtain information from the Canadian Cancer Society. Students can develop their own definition for cancer after reading the pamphlets. • Film/filmstrip on possible causes of cancer, diagnosis and treatment. • Do you know someone who has or had cancer?	*Canadian Cancer Society* *Health*, pp. 442–448 *Disease Defense*, p. 61–69
b) The cell – where it begins	• The cell is the building block of the body as are the bricks of a building. a) Draw a typical cell and list 6 important cell parts and their functions b) Lab: Observe cells c) Ask: What are tissues?	*Disease Defense*, pp. 22–34 *Principles of Science II*, p. 21 *Principles of Science II*, p. 22–23
c) Cells grow, reproduce and repair themselves	• Diagram how a single body cell reproduces. a) Ask: What are chromosomes? b) Cancer may begin when something has gone wrong with the cell's DNA control mechanism, allowing growth to go out of control. c) <u>Read</u>: Article: Implications of Chernobyl Biomedical Consequences (radiation and cancer), or Down's Syndrome and Radiation.	*Principles of Science II*, p. 108 *Diesease Defense*, p. 76 *Article: Issues in Science & Technology* *Science Process & Discovery*
d) Runaway Cells	• Invite an oncologist or crystologist (cancer specialist) or a radiologist to discuss the latest methods of detecting and treating cancer; the types of cancer and/or the status of current research aimed at eradicating cancer. • Student may: – draw a malignant or benign tumour – list the warning signals of cancer – create a bulletin board that illustrates each of these along with guidelines for lowering your chances of developing cancer.	*Disease Defense*, pp. 64

CONCEPT 1: Know how non-communicable diseases result from an interaction of variables (e.g., poor nutrition, compromised immune system, alcohol, smoking). (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.3 Diseases can be communicable or non-communicable CANCER AND THE CELL e) The risks people take	• Make up an advertisement or poster illustrating the high risks of conditions of cancer.	
f) Diagnosis	• Find magazine articles/pictures, newspaper articles, etc., showing visible pictures of tumours by: CAT scan, thermogram, X–ray, and so on. • Create your own poster size drawing/painting of a body part shown through a CAT scan.	*National Geographic*, pp. 3,5,19,20, 22,23
g) Cures and treatment	• Imagine you are a doctor. Make up a story to present to a patient who has just been diagnosed with cancer: – list the facts about their type of cancer – outline the choice of treatment vs. no treatment.	*Disease Defense*, pp. 61–69
h) Follow–up/conclusion activities.	• Prepare a short survey of questions to be passed out to other students of the school in order to gather information that they may or may not know with regard to cancer. Publish the results in a form of a bar graph in the school newspaper. • Collect newspaper articles or recent magazine briefs about cancer and paste them into a scrapbook entitled Cancer & the Cell; be sure to date and reference the articles (ongoing).	Local newspaper (use library as a source)

CONCEPT 1(c): Know how non-communicable diseases result from an interaction of variables (e.g., poor nutrition, compromised immune system, stress, heredity alcohol, smoking.)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.3 Diseases can be communicable or non-communicable. HEART DISEASE	• Labs may include: a) observing blood cells through a micro-slide viewer b) observing circulation in a fish tail c) list factors contributing to heart disease.	*Disease Defense*, pp. 55–56
	• Show how decreasing the size of the artery (a tube) will cause increased blood pressure. Flow a given volume of water through tubes of different sizes to see results. What factors cause narrowing of vessels in the circulatory system?	
	• Gather information on deficiency diseases such as: a) Diabetes – See a film on stress to observe how diabetes may result after prolonged stressed conditions. b) Cystic Fibrosis – Invite a speaker in from the C.F. Foundation to explain this disorder.	*Disease Defense*, pp. 70–73
	• Write letters to a foundation (e.g., heart, cancer, Alcoholics Anonymous, etc.) and gather pamphlets and other information. Make a bulletin board displaying the information.	

CONCEPT 1: Diseases can be communicable or non-communicable.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.4 Describe the steps that can be taken to reduce the risk of contracting disease.	• Examine methods used to prevent food poisoning. • What factors increase a person's risk of heart disease?	*Disease Defense*, pp. 17–21 *Disease Defense*, pp. 55–56

CONCEPT 2: The microscope is an essential tool for looking at microbes and cells.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Relate structure to function in a light microscope.	• Label a diagram of the parts of the compound microscope.	
	• Observe lens paper at a) different magnifications b) at different iris diaphragm openings. • Prepare a wet mount of the letter "e." • Practice proficiency in using a microscope by observing the letter "e" and drawing it under each magnifying power. • Observe prepared slides under the microscope/microslide viewer. a) plant cells b) animal cells (prepared cheek cells & blood cell samples) c) bacterial cells Note: When using the light microscope for observing bacterial cells, an oil immersion lens is required. If not available, one may use microslide viewers. Bacteria and Viruses can be easily seen as they are shown much larger then their actual size. With each slide comes a short explanation in the microslide jacket. They are easy to use at the student's desk (they may be purchased from any scientific distributor – see catalogues).	*Disease Defense*, p. 14 Microslide sets
2.2 Describe how the invention of the electron microscope made possible the study of viruses and extremely small structures within the cell, leading to great advances in science.	• Label a simplified diagram outlining the major differences between a light microscope and compound microscope. • Observe slides, pictures, etc., of electron micrographs of various cell bacteria, viruses, etc., and structures within cells. (See Note above) • Find out how the electron microscope was developed.	*Disease Defense*, p. 32

CONCEPT 3: The human body has natural systems of immunity.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Describe how immunity can be achieved through contact with specific diseases.	• Film/filmstrip on the bodies natural lines of defense: The Immune System.	*Our Immune System. The Wars Within (National Geographic)* *Disease Defense,* p. 18
3.2 Know how antibodies and phagocytes function as major components of the body's defence/immune system.	• Observe a prepared slide of white blood cells under a microscope or use a microslide viewer.	
3.3 Explain that through placental transfer and breast milk the maternal system's antibodies pass to the offspring, providing some degree of immunity to the child.	• A mock simulation with clay may be used to illustrate how antibodies in the maternal system combat RH antibodies of the developing baby.	
3.4 Identify examples of abnormal immune responses (e.g., allergies, AIDS).	• Film/video: Acquired Immune Deficiency Syndrome (AIDS). • Collect any newspaper or magazine articles for the scrapbook. • Make a series of drawings, illustrating the process occurring in the body when attacked by the AIDS virus. • Investigate the progress in the development of vaccines for hepatitis, AIDS and the common cold. • See the local health unit for educational materials and pamphlets on AIDS and set up a bulletin board. • Take a field trip to a medical laboratory and observe the functioning microbiology section. a) What techniques are used to stop the spread of diseases? b) What techniques are used to find out what caused a disease or infection? • Explain what happens when the bodies immune system fails to function and becomes over-sensitive (e.g. allergies).	*Health*, pp. 420–421, *Our Immune System. The Wars Within (National Geographic)* *Faces of Aids,* Aug 10/87 *(Newsweek)* *Disease Defense,* pp. 39–44. *Time, Life* *Disease Defense,* p. 42 pp. 48–52

CONCEPT 4: Biotechnical and biomedical processes have greatly enhanced our immune systems.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Explain why aseptic technique is critical to modern medical practice (historical development).	• Demonstrate aseptic technique a) Innoculate the E. Coli (Escherchia coli) bacteria onto a petri plate: – using aseptic technique – without using aseptic technique.	
4.2 Relate how artificial immunization (vaccines) prevents the contraction of many diseases.	• Write a story either on biological warfare or on a new killer virus, and how we could protect ourselves. • As a genetic engineer, design a microbe to help society (use any medium).	*Disease Defense*, pp. 8–9
4.3 Describe how antibiotics suppress bacterial growth.	• Try to simulate (recreate) Alexander Fleming's experiment. • View a film or read about the discovery of penicillin and other antibiotics on the growth of microbes. • Examine the effects of household disinfectants on bacterial growth.	*How It Works*, p. 118 *Disease Defense*, pp. 45–47 *Science at Work: Technology; Biotechnology*, pp. 23–25 *Science: Process & Discover*, p. 59
4.4 Identify advances in genetic research which relate to disease defence (e.g., the splicing and cloning of genes to make antibiotics).	• Illustrate the process of gene splicing and cloning. List the applications of gene splicing and cloning. • Clone carrot cells, using a kit (see Science catalogues). • Filmstrip: *Genetic Engineering Prospects for the Future.*	*Disease Defense*, pp. 83–88, 92 *Future Life*, pp. 56, 68, 71 *Science at Work: Technology; Biotechnology*, pp. 28–29 *Disease Defense*, pp. 89–91

CONCEPT 5: Immunization technology is based on scientific principles.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
5.1 Trace the historical development of immunization therapy (Jenner, Pasteur, Koch, Salk). 5.2 Describe how the body recognizes a foreign substance (antigen) and can produce specific antibodies against it. 5.3 Describe how immunity can be induced by injection with attenuated or killed micro-organisms (e.g., measles, mumps, polio, rabies). 5.4 Outline how injection of antibodies directly into an individual results in passive immunity (e.g., tetanus, hepatitis).	• Explain the process of pasteurization. • Simulate Louis Pasteur's experiment with swan neck flasks, which shows the discovery of the effects of the micro-world. • Read/film/video on: a) Louis Pasteur "*The Preparation of Artificial Vaccines*" b) Edward Jenner and Vaccination c) Jonas Salk d) Dr. Alberta Sabin and the Polio vaccine e) Koch • Make a mural/poster tracing the major historical points on immunization technology (display). • Invite a health nurse in to discuss the biological principles behind immunization, specific vaccines, and those vaccines required in order to travel to certain countries. • Make a list of each of the diseases: construct a chart showing the causes, signs and symptoms, and/or defects of the disease, treatment, irradication. • Explain or use a diagram to show how this passive immunity results.	*Disease Defense*, pp. 10 *Applied Science*, p. 96 *Great Scientific Experiments*, p. 96 *Health*, pp. 418–419 *Disease Defense*, pp. 39–44 *Great Scientific Experiments*

CONCEPT 6: Factors behind biotechnical and biomedical processes have societal implications.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
6.1 Explain that vaccines provide immunity against diseases that were formerly fatal.	• Collect statistics from the health unit and draw graphs illustrating that vaccines provide immunity against diseases that were at one time fatal.	*Disease Defense*, pp. 39–44
6.2 Cite two examples of transplants or implants that may increase life expectancy.	• Outline the problems associated with tissue typing and implant rejection problems (see newspapers, follow the history of the trials of a heart transplant recipient). • View a film/video on new technology for implanting or transplanting organs or artificial organs and/or joints. • Comment on and research the following: pacemaker, hemodialysis (artificial kidney), corneal transplant, hear transplant, a new hip. • Discuss the problem of tissue rejection from transplants in context with blood typing and knowledge of antigen/antibody reactions. • Draw a lifesize body and show the various organs and joints that have been transplanted and replaced. • Read about the Jarvik heart and baboon hearts • Collect current newspaper/magazine releases on transplants. • Draw a time chart showing the important historical dates of transplants and development of new organs, tissues and joints. • Invite a speaker from the War Amputees Society or a branch dealing with handicapped people. Observe the inventions used for people who have lost limbs and are using artificial ones. What materials are used? • Draw or paint a picture using your mouth or feet. Comment on the experience later.	 *Future Life*, p. 25 *Life Magazine* *Health*, pp. 45, 185, 440

CONCEPT 6: Factors behind biotechnical and biomedical processes have societal implications. (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
6.3 Identify and describe two techniques for genetic screening that make it possible to detect genetically transmitted diseases and disorder.	• Label a diagram of the developing fetus in the womb. • List the steps involved in the technique of amniocentesis to detect birth defects. • What are the disadvantages of amniocentesis? • Examine and prepare human karyotype (chromosome) charts.	*Biology: A Canadian Laboratory Manual*, pp. 137–141
6.4 Describe the interaction of a biomedical process with science and society.	• Review the implications associated with amniocentesis, transplant technology, and gene manipulation. • What is diabetes? • Two famous Canadian researchers are credited with discovering the cure for diabetes. Who were they and what did they do?	*Disease Defense*, p. 92 *Disease Defense*, p. 70–73 *Disease Defense*, p. 71
6.5 Cite one example of scientific research into the diseases of domestic crop plants leading to the development of technology that allowed the production of disease – resistant strains.		

UNIT II: ENERGY CONSUMPTION

Overview

Students will use observation and recording of personal energy consumption patterns to establish a data base. Analysis and application of this data should lead to an awareness of technological processes involved in personal and global energy consumption.

The emphasis of this unit is the nature of science.

SPECIFIC LEARNER EXPECTATIONS

Attitudes

The student will be encouraged to:

1. Develop a positive attitude toward mathematical and scientific process skills.
2. Develop responsible attitudes toward energy consumption in relation to personal and global needs.
3. Be receptive to new ideas, insights and change.

Skills

The student will be expected to demonstrate an ability to:

1. Select and apply appropriate problem-solving strategies.
2. Apply specific data collection, organization, and interpretation skills.
3. Identify trends in data and make predictions from those trends.
4. Use precise symbols and terminology.
5. Apply simple calorimetry to measure the energy output of various foods.
6. Apply simple equipment and techniques to measure two other forms of energy (e.g., light, sound).
7. Apply monitoring techniques and record personal kilojoule intake.
8. Analyse data from a personal caloric intake record.
9. Develop an improved diet plan based on the analysis.
10. Apply monitoring techniques and record a personal household's energy consumption.
11. Analyse data from a personal household energy consumption record.
12. Devise a more efficient plan for household energy consumption based on the analysis.
13. Devise a simple energy system model to demonstrate the conservation of energy.
14. Calculate the efficiency of a basic energy system.

Concepts

Students will be expected to demonstrate an understanding that:

1. **We obtain energy from the foods we eat.**

    1.1 Identify the sun as the ultimate source of food energy.
    1.2 Describe the body systems responsible for conversion of food into energy.
    1.3 Identify and describe the process of energy conversion performed by the human body.
    1.4 Identify the basic components of a balanced diet.

Students will be expected to demonstrate an understanding that:

2. **Energy can be measured in quantitative terms.**

    2.1 Identify and define the units for measuring energy from foods.
    2.2 Examine the equipment and techniques for measuring food energy.
    2.3 Identify other forms of energy present in the world.
    2.4 Identify equipment, techniques, and units used to measure other forms of energy.

Students will be expected to demonstrate an understanding that:

3. **Personal energy consumption can be determined.**

    3.1 Identify the forms of energy consumption in the household.

Students will be expected to demonstrate an understanding that:

4. **Observable phenomena play a role in the development of scientific knowledge.**

    4.1 Examine how energy consumption data has led to knowledge that can be applied to the development of more efficient energy use practices.

Students will be expected to demonstrate an understanding that:

5. **Energy within a system has input, conversion, and output components.**

    5.1 Identify the energy components within a system.
    5.2 Describe the flow of energy within the human body.
    5.3 Describe the flow of energy through an ecosystem.
    5.4 Investigate energy consumption, conversion and output within an energy powered device.

Students will be expected to demonstrate an understanding that:

6) **Total energy of a system is conserved.**

    6.1 State the law of conservation of matter and energy.
    6.2 Explain the law of conservation of energy in terms of a selected energy system model.

Students will be expected to demonstrate an understanding that:

7. **Efficiency of an energy system can be calculated.**

    7.1 Describe the methods and techniques for determining the efficiency of an energy system.
    7.2 Suggest ways of improving the efficiency rating of an energy system.
    7.3 Compare and contrast two energy systems in terms of their overall efficiency.

Students will be expected to demonstrate an understanding that:

8. **There are renewable and non-renewable energy sources.**

    8.1 Differentiate between renewable and non-renewable energy sources.
    8.2 Identify and describe one non-renewable energy source.
    8.3 Identify and describe one renewable energy source.
    8.4 Describe ways of using renewable energy sources to improve the efficiency of local and global energy consumption.
    8.5 Describe the effects of using non-renewable sources on local and global energy consumption.

CONCEPT 1: We obtain energy from the foods we eat.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 Identify the sun as the ultimate source of food energy.		
1.2 Describe the body systems responsible for conversion of food into energy.	• Trace the path of a sandwich or hamburger through the digestive system, by labelling a diagram of the parts.	*Body in Balance*, pp. 22–27 *Energy for Living*, p. 6
1.3 Describe the process of energy conversion performed by the human body.	• Jog on the spot or skip for 1 minute. a) List the factors that tell you your body has done work. b) Ask what was needed in your body for it to do work? c) Ask what relationship does this have with food? • Build a board game to show the steps involved in the breakdown of food molecules: a player starts with a number of tokens – every time energy is released and lost as heat the player loses a token (this happens if they land on a square that says "heat lost") – when energy is stored in bonds of ATP (adenosine triphosphate) the player gets three tokens. • Draw a diagram outlining the main steps in the cellular respiration of glucose.	*Energy for Living*, p. 5 *Energy for Living*, pp. 8–10

CONCEPT 1: We obtain energy from the foods we eat. (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.4 Identify the basic components of a balanced diet.	• Collect labels from various foods and make a list of ingredients found. – Are they carbohydrates, fats or proteins, or do they contain all? – Construct a chart that names the food and identifies the nutrients it contains. Include a column on the approximate energy values in kilojoules.	*Energy for Living*, pp. 23–24 pp. 25–29

CONCEPT 2: Energy can be measured in quantitative terms.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Identify and define the units for measuring energy from foods.	• Energy value of food is measured in a heat unit called a kilojoule. Different foods give different amounts of energy. – Determine how much energy is stored in food. – Ask if energy released from peanuts can be used to heat water.	*Energy for Living*, pp. 18–22 *Science at Work, Energy*, pp. 17–19 *Science at Work, Body Maintenance*, p. 14
2.2 Examine the equipment and techniques for measuring food energy.	• Build a calorimeter. a) Label the components needed and their functions. b) When food is burned it gives off heat, measure the amount of heat using different food groups (e.g. carbohydrates, fat & proteins) with a calorimeter.	*Energy for Living*, pp. 18–21
2.3 Identify other forms of energy present in the world.	• Make a list of the ways we get energy. – solar energy – sound energy – wind energy – electrical energy – hydro–electric energy – nuclear power – fossil fuel energy – food energy • Energy may be observed in different forms and may also be stored. – mechanical energy – chemical energy – kinetic energy – light energy • Draw a diagram depicting each form of energy.	*Energy for Living*, p. 36 *Science at Work: Energy*, pp. 5, 6–8, 9–10 pp. 13–16

CONCEPT 2: Energy can be measured in quantitative terms.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.4 Identify equipment, techniques and units used to measure other forms of energy.	• Measure the power used by a small light bulb. a) Record the number of amperes and volts, then disconnect the battery. b) Ask what amount of power (in watts) the bulb is using.	*Energy for Living*, pp. 47–48
	• Find out how many joules of electrical energy (watts = volts x amperes) are used by a hair dryer in one second, one minute, one hour.	*Energy for Living*, p.49
	• Ask how much heat energy can be obtained from an electrical heater.	*Energy for Living*, p. 39
	• Find out the strength of different muscles using bathroom scales.	*Science at Work*, p. 6 *Body Maintenance*
	• Beat water, with a manual egg beater. What do you feel?	
	• <u>Solar collectors</u> gather heat from sunshine — radiant energy. Radiant energy may be measured by temperature. The temperature of water can be raised by passing water over solar collector panels.	*Energy for Living*, pp. 71–74
	a) Find out whether a black-coated tin can will heat water faster than a plain tin can.	*Science at Work: Energy*, pp. 30–32
	b) Use a mirror to focus right rays. Find out if it changes the temperature of a thermometer.	*Energy for Living*, p. 75
	• Energy created by <u>sound</u> is observed when objects vibrate. a) List observed vibrations. Then list vibrations that create sound that cannot be seen. b) Strike a tuning fork and touch the prongs to the surface of some water. Describe what happens and why.	*Understanding the Technology*, pp. 37–44

CONCEPT 2: Energy can be measured in quantitative terms. (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.4 Identify equipment, techniques and units used to measure other forms of energy.	• <u>Sound energy</u> depends mainly on the amplitude of vibration of the source of sound and the distance from the source to our ears. Loudness is measured in decibels (dB). Using a sound meter, measure the sound level of noises found in different environments.	
	• <u>Measuring Electricity</u> a) Define electric current & electric charge.	*Energy for Living*, pp. 39–52
	b) Measure electric current & calculate electric charge. c) Define and measure voltage. d) Define and calculate energy & power. e) Using graphs, identify points of maximum and minimum potential or current for a flashlight. Construct a diagram showing the <u>flow of energy</u> back to the original source (the sun) from a molecule of food.	*Physics: A Practical Approach*, pp. 298–300 pp. 302–303
	• A number of experiments can be performed to show how solar energy is converted into food. a) Is light required to make food in a plant in the process of photosynthesis. b) Find out what green plants give off when exposed to light.	*Energy for Living*, pp. 11–17
	• Find out how many kilojoules/hour are used in various forms of mechanical energy (e.g., bike riding, walking, running, pushing a motorcycle, swimming).	*Energy for Living*, pp. 31–34
	• Identify products found at home or school that operate on electrical energy.	p. 49
	• How is energy changed when you use electricity?	

CONCEPT 2: Energy can be measured in quantitative terms. (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.4 Identify equipment, techniques and units used to measure other forms of energy.	• Ask what a nuclear power plant uses to produce electricity.	
	• Ask how water is used to generate electrical energy.	*Physics: A Practical Approach*, p. 361 *Science at Work: Energy* pp. 11–12
	• On a map, shade in the regions of Canada to show the locations of fossil fuel resources. List how each of the different fuels transfer their energy into heat energy.	*Energy for Living*, p. 57
	• Make a model wind turbine.	*Science at Work: Energy*, pp. 26, 29

CONCEPT 3: Personal energy consumption can be determined.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Identify the forms of energy consumption in the household.	• List the foods you ate for your last meal. a) Following Canada's Food Guide, class these food items according to the four food groups. b) Determine whether the meal was nutritious according to the Canadian standards. c) Keep track of calories (kilojoules) for a week and closely examine labels. Determine whether eating habits can be improved.	*Energy for Living*, pp. 29–31
	• Examine a table of energy outputs for fitness activities. Calculate which exercise would be the best and for how long the exercise would have to be done to lose 1 kilogram of fat.	*Energy for Living*, pp. 31–33
	• List all the energy output activities you do in a day. a) Find out what your energy output is. b) How many kilojoules of food energy do you eat in a day? c) Ask how many kilojoules you need to stay at your present weight. d) Estimate body fat using the "skin-fold" technique.	*Energy for Living*, p. 30–31
	• Collect information about various diets being advertised. Determine the consequences of these diets.	
	• Read: Article "Nutrition and the Competitive Athlete" and "Nutrition and You: The Weekend Athlete."	*Olympic Resource Kit*
	• List all the appliances and gadgets in the home that consume energy. Break down the list into two categories. List under "with heating element" and "without heating element".	*Energy for Living*, p. 49
	• Compare the power used by different household devices.	*Physics: A Practical Approach*, pp. 318–319

CONCEPT 3: Personal energy consumption can be determined. (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Identify the forms of energy consumption in the household.	• Many appliances have an energy guide label showing the number of kilowatt hours of electricity the appliance uses per month. a) Using the label, calculate the amount of electricity used by appliances per month. b) Find the amount of consumption for one year, using C = E x 12 where C = yearly electrical consumption in kilowatt hours, and E = the energy guide rating.	*Energy for Living*, p. 51
	• Determine which costs more to run, appliances with heating elements or with motors.	*Energy for Living*, pp. 45–46
	• Read the meter at home and calculate the electrical energy used and its cost. Compare your results to the next power bill.	*Science at Work, Domestic Electricity*, pp. 31–32
	• Reducing your energy bill: a) Read a utility bill. b) Calculate the amount of energy you used in the month. c) Find out about the other charges on the bill (e.g., Municipal Franchise Assessment).	*Physics: A Practical Approach*, pp. 322–325

CONCEPT 4: Observable phenomena play a role in the development of scientific knowledge.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Examine how energy consumption data has led to knowledge that can be applied to the development of more efficient energy use practices.	• Devise a list to show an improved plan to become more energy efficient in your home. • Energy cost: a) Find out how your home is heated. Which energy source is used? b) What are the advantages of electricity over burning fuels? c) Given the information, compare the cost of heat energy from various sources. • Make posters to advertise to the school how to cut its energy consumption and the importance of doing so. • Monitor the schools energy consumption and cost. Devise an improvement plan and check the energy costs after two months.	
	• Do research on fossil fuels and the various methods of extraction.	*Energy for Living*, p. 53
	• Explain hydroelectricity. • Research nuclear energy. (See Teaching Strategies SQ3R method of research).	*Physics: A Practical Approach*, pp. 360-361 *Principles of Science II*, p. 437
	• Insulation helps to keep heat from escaping. a) Experiment to show how insulation works b) Experiment to find if different materials are better insulators.	
	• Compare electrical energy and heat energy. How much heat energy can you get from an electrical heater? Use an immersion heater to heat water, and record the temperature.	*Science at Work: Domestic Electricity*, pp. 27-32
	• Find out which electric stove element uses more electrical energy to bring the same amount of water to boiling - the larger or smaller element?	

CONCEPT 5: Energy within a system has input, conversion, and output components.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
5.1 Identify the energy components within a system.	• Analyse diagrams depicting energy systems: – playing volleyball – playing a piano – driving a motorbike/automobile. • All of the above require an energy input and output. – name the input – name the output – what happened in between? This is the conversion process.	
5.2 Describe the flow of energy within the human body.	• We receive energy from plants. Examine how plants convert radiant energy into sugar and starch, and how plants are used by animals & vice versa.	*Energy for Living*, pp. 11–17
5.3 Describe the flow of energy through an ecosystem.	• Cut out pictures of plants and animals in an environment of your choice showing how each interacts with the other. (Food chains) Determine the flow of energy.	
5.4 Investigate energy consumption, conversion, and output within an energy–powered device.	• For each of the energy–powered devices, construct a chart showing the components of the energy system. Use the following headings: energy consumed, conversion, and output. • Use heat to turn a wheel with an electric kettle and a cork wheel • Draw a simplified model of a steam engine. • Heat a wire with your own hands. Bend a coat hanger with your hands. Feel the spot that was bent, with your fingers. • Warm a bottle by shaking. To measure the heat change, fill the bottle with sand and a thermometer. This is another example of mechanical energy turned into heat.	 *Applied Science*, p. 11 *Invitations to Science Inquiry*, p. 152 *Invitations to Science Inquiry*, p. 151 *Invitations to Science Inquiry*, p. 151

CONCEPT 5: Energy within a system has input, conversion, and output components. (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
5.4 Investigate energy consumption, conversion, and output within an energy-powered device.	• Take apart an old toaster, kettle or iron and observe the element.	
	• Construct an electric circuit and study the conditions required to produce a continuous flow of electricity.	*Science at Work: Domestic Electricity,* pp. 11–23
	• Construct a lightbulb and investigate some of the factors that make a good lightbulb. Use wire and copper wire.	
	• Construct a simple generator and study the electric current it generates.	*Physics: A Practical Approach,* p. 295
	• Investigate some of the properties of magnetic fields and show that a magnetic field is produced when current flows in a wire. Also construction of a galvanometer will detect weak electric currents.	*Physics: A Practical Approach,* pp. 332–336
	• Build an electric buzzer or bell.	*Physics: A Practical Approach,* pp. 339–342 *Science at Work, Domestic Electricity* pp. 24–26
	• Construct a simple water turbine and have it do some work using the energy from falling water. Change variables such as water pressure, by having water fall a greater distance or by turning the tap on harder.	*Invitations to Science Inquiry,* p. 215
	• Make a simple cell using the principle that acid reacts with zinc and copper to form electrical energy shown by a volt meter.	
	• Make a water heater: • Make a heater coil by wrapping wire around a glass rod. • Put heater in water. • Connect it to a battery or a supply of low voltage electricity. • Note the changes.	*Science at Work Domestic Electricity,* pp. 27–30

CONCEPT 5: Energy within a system has input, conversion, and output components. (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
5.4 Investigate energy consumption, conversion, and output within an energy-powered device.	• Using a solar cell (made of two metals) allow the sun's energy to hit the cell to produce a small electric current, measured in microamps. – discuss the solar calculator – discuss the use of solar blankets in swimming pools	*Applied Science*, p. 17
	• Car electricity: Describe what is necessary for electricity to be used in a car. • Ask what a battery in a car does. • Make a battery cell to see how it works. • Use the principle of fuel ignition by an electric spark to explain the energy transformation. Draw diagrams. • Describe the functions of the parts of a fuel system in a car to explain how fuel energy is transformed into mechanical energy. • Draw a diagram to illustrate how a nuclear reactor works to obtain energy. Gather pamphlets on the nuclear power stations in Canada.	*Science at Work, Science of the Motor Car*, pp. 11–16
	a) Using soap bubbles as a model for the actual process of fission and fusion, demonstrate the reaction by pulling the soap bubbles apart with another wire loop. b) Explain the dangers of using nuclear energy e.g., radiation leaks, doses of radiation. c) Debate the pros and cons of the use of nuclear energy.	*Invitations to Science Inquiry*, p. 154

CONCEPT 6: Total energy of a system is conserved.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
6.1 Describe the law of conservation of matter and energy.	• List all the energy conversions in a car to illustrate that the energy is changed from one form to another but not changed in amount. • Start a recycling campaign at school. Collect aluminum cans and then find out what will be done with them. • If there is a recycling centre close by, plan a trip to find out how solid wastes are separated and recycled. An alternative to this is to write a recycling centre for information. • Draw a model showing that windmills with generators can store electricity in batteries like those used in cars. • Windmills can also turn the wind's kinetic energy into potential energy. They can be used to pump water uphill into storage tanks or reservoirs, and then used to flow downhill through turbines to generate electricity. a) Diagram this model first. Devise ways that this could be demonstrated in the classroom. b) Have students make model windmills.	
6.2 Explain the law of conservation of energy in terms of a selected energy system model.	• Explain using a diagram or referring back to the activity that a waterfall's potential energy can be used to drive turbines to create hydro-electricity. • Make posters depicting ways we can conserve energy.	*Physics: A Practical Approach*, pp. 360–361

CONCEPT 7: Efficiency of an energy system can be calculated.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
7.1 Understand the methods and techniques for determining the efficiency of an energy system.	• Efficiency is the ratio of its output energy to its input energy (output energy can never exceed input energy). Calculate the efficiencies of various steps in an energy system by which we could obtain electricity by burning natural gas. • Calculate the efficiency of a large car and compare it to a small car.	
7.2 Suggest ways to improve the efficiency rating of an energy system.	• Explain, using a model, how a home heat pump is used to heat a house during the winter and used as an air-conditioning unit in the summer. • Investigate the efficiency of a light bulb in producing heat. • Investigate the efficiency of a light bulb as a source of light • Find out the differences between fluorescent and incandescent bulbs.	*Seeds*, p. 39
7.3 Compare and contrast two energy systems in terms of their overall efficiency.	• Compare the use of burning propane for cooking with electricity for cooking. • Compare and contrast the use of two different fuels for cars. • Compare the energy efficiency of pedalling a bicycle with the efficiency of a car.	

CONCEPT 8: There are renewable and non-renewable energy sources.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
8.1 Differentiate between renewable and non-renewable energy sources.	• Cut out magazine pictures and words or draw your own, to illustrate: a) renewable energy resources b) non-renewable energy sources.	*Energy for Living*, p. 70
8.2 Identify and describe one non-renewable energy source.	• Identify on a map of Canada the areas where non-renewable resources are found. • Visit a site where a non-renewable energy source is found, or gather information on one non-renewable source and set up a display. Have students write letters to Syncrude or Suncor — Ft. McMurray — for information.	
8.3 Identify and describe one renewable energy source.	• Water, a source of energy is considered renewable. a) Locate the hydroelectric-generating stations in Canada. b) Write for brochures of information about the construction and operation of its installations. c) Label a diagram of the water cycle. Notice that another energy source is the sun. d) Construct a waterwheel. • Solar energy a) Create a poster or collage showing the link between the sun and other forms of energy. b) Experiment to observe how the angle of a burning lightbulb affects the speed at which the vanes of a radiometer revolve. Collect the data and graph the results. • Wind energy a) How do windmills work? Experiment to show how the angle of the blades of a windmill affect the speed at which the vanes of the windmill revolve. b) Experiment to show how a windmill can be used to store energy.	

CONCEPT 8: There are renewable and non-renewable energy sources. (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
8.4 Describe ways of using renewable energy sources to improve the efficiency of local and global energy consumption.		
8.5 Describe the effects of using non-renewable sources on local and global energy consumptions.	• List the by-products of coal and oil. • Review graphs depicting the use of different fossil fuels around the world. • Review statistics for the production of oil (number of barrels/year). • Discuss the social and political impact on oil production. • In order to realize the impact of non-renewable sources of energy, trace your travels of one day and night to list all the things that energy does for you. This can be depicted using a flow chart. • Discuss global concerns: a) Depletion of fuels and thus alternative methods for energy. Have students collect or find newspaper articles relating to energy crisis, or alternatives. b) The use of nuclear reactors: read a recent article dealing with this concern. • Draw a picture to illustrate how energy systems are related to economics. Discuss.	*Energy for Living*, pp. 54–55

UNIT III: MATERIALS WE USE

OVERVIEW

Students will study a variety of materials and their application. The interaction of science and technology in the research, development and production of materials to satisfy a societal demand will be addressed. The relationship of the properties of a specific material to its application will become evident through personal scientific investigation.

The emphasis of this unit is the nature of science.

SPECIFIC LEARNER EXPECTATIONS

Attitudes

The student will be encouraged to:

1. Be aware that the technology of materials can solve practical problems.
2. Appreciate the relationship of science principles to the properties of common materials.
3. Appreciate the contribution of scientific procesess and skills to the research and development of the technology of materials.

Skills

The student will be expected to demonstrate an ability to:

1. Design an experiment to investigate several properties of a selected material.
2. Carry out the experimental design on a selected material(s).
3. Apply data collection, organization, and interpretation skills.
4. Communicate results clearly.
5. Propose applications of the selected material, based on its properties.
6. Assess materials critically.

Concepts

Students will be expected to demonstrate an understanding that:

1. **A material is the substance of which a thing is or can be made.**

    1.1 Define matter.
    1.2 Define the atom as the basic structural unit of matter.
    1.3 Relate the behaviour of atoms and molecules to the Kinetic Molecular Theory.
    1.4 Relate the properties of a material to its composition.

Students will be expected to demonstrate an understanding that:

2. **The properties of materials can be investigated through controlled experimentation.**

Students will be expected to demonstrate an understanding that:

3. **The technological process of producing a product can be evaluated.**

    3.1 Describe how products are derived from natural or synthetic sources.
    3.2 Identify products that are in everyday use.
    3.3 Investigate the industrial process involved in the manufacture of two products.
    3.4 Realize the advantages and disadvantages of the industrial processing of resources into a product.

Students will be expected to demonstrate an understanding that:

4. **The use of materials has changed many aspects of life.**

    4.1 Describe how non–biodegradable products can cause environmental problems.
    4.2 Assess the need for biodegradable products.
    4.3 Describe how products and their applications can change over time as new materials and technologies are developed.
    4.4 List the properties of four selected raw materials and identify their contribution to our quality of life.

Note: This unit incorporates the following segments.

1. Metals
2. Plastics
3. Fiber and Fabrics
4. Ceramics
5. Material used for building homes
6. Glass

In order to cover the specific learner expectations, a teacher may cover one topic in depth, two or more segments in combination, or select activities from each topic area.

CONCEPT 1: A material is the substance of which a thing is or can be made.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 Define matter as any substance from which something is made.	• Observe/examine a variety of common materials: concrete, wood, plastic, metals.	
1.2 Define the atom as the basic structural unit of matter.	• Build simple molecules from molecular kits.	
1.3 Relate the behaviour of atoms and molecules to the Kinetic Molecular Theory.	• Simulate brownian motion and heat by vibrating marbles.	
1.4 Relate the properties of a material to its composition.	• Build a molecular model of a simple carbon chain (polymer) that resembles nylon. • Ask: How soft is plastic? • List all the material made from plastic. • Build a molecular model of a plastic polymer.	*Principles of Science, Lab Book* *Materials & Molecules*, pp. 46–52

CONCEPT 2: The properties of materials are investigated through controlled experimentation.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
	• Look around the home and identify the materials that make up the "things" in your home; e.g., ceramics, metals, plastics, wood, paper, fabric/textiles, concrete, brick, plaster, glass.	
	• Construct a chart with each of the materials identified and fill in the following: material, use in home, some properties (e.g., colour, textures, hard, soft).	
	• Construct a chart similar to the one above only identify materials specifically used in construction of buildings, bridges and houses.	
	• Observe a variety of fabrics under the microscope and draw their shapes.	*Science at Work, Fibres and Fabrics*, pp. 1–2,
	• <u>Metals</u>	
	a) Name the common properties of metals.	
	b) Test or observe the properties of metals – malleable (bendable not breakable); shiny metallic luster (observe); silver–grey in colour except for gold and copper; solids, except for mercury, are good conductors of electricity.	*Principles of Science II*, p. 291 *General Science, p. 102* *Materials & Molecules*, pp. 11–13
	c) Experiment to identify some metals by flame colour.	*Principles of Science*, pp. 293–294
	d) Extract pure metal: using an oxide of a metal, a little piece of pure metal could be produced.	
	e) Purify copper for use in electricity.	
	f) Metals have been used for many centuries for various functions. We use different metals for different purposes, taking into account strength, lightness, ease of working, colour and even taste – using copper, aluminum and steel, find out which metal would best be suited to make a spring for some purpose – test springs with weights – test the stretching limit of metals – test sheet metals, name the best use for each metal.	

CONCEPT 2: The properties of materials are investigated through controlled experimentation. (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
	• Corrosion a) Test to see if metals can be damaged by air, water or solutions. b) Observe corrosion reactions.	*Science at Work*, p. 8 *Building Science* *Materials & Molecules*, pp. 17–21
	• The strength of a bridge depends on the material (metal) used and also the shape and length of the bridge.	*Science at Work*, *Building Science* pp. 16–17
	• Protective Coatings a) How well do protective coatings work?	*Materials & Molecules*, pp. 22–25
	b) The process of coating with zinc is called galvanizing. Galvanize an object by means of an electric current (electroplating).	*Science at Work*, *Building Science*, p. 10
	c) Find out if iron can be protected by joining it to another metal.	
	d) Conduction of heat by metals – do all conduct equally well; which metal melts the most paraffin?	
	• Fibers and Fabrics a) Determine the properties of synthetic fibres and contrast these with the properties of natural fibres; e.g., washing, compare drying time, wrinkles, ravels, bleach effects, dyeing, shrinkage.	*Principles of Science II Teachers Activity Book*, p. 139
	b) Identify fabrics by burning them. c) How can fabrics be flame proofed?	*Principles of Science II*, *Teachers Activity Book* p.254 or *General Science*, p.168
	d) Nylon and rayon can be produced in the lab. e) Find the strength of different threads.	*Science at Work: Fibers and Fabric*, pp. 4–5 pp. 12–14
	f) Which fabrics stand up to wear (rubbing)?	*Science at Work, Fibers and Fabric*, pp. 18–19

CONCEPT 2: The properties of materials are investigated through controlled experimentation. (continued)

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
	g) List the washing instructions from different types of clothing and identify the symbols.	*Science at Work: Fibres and Fabrics*, p. 24–25 *Materials & Molecules*, pp. 31–36
	h) Experiment to find out if fabrics are insulators.	*Science at Work: Fibers and Fabrics*, pp. 20–21
	i) Find out the different chemicals used at the dry cleaners and any special processes they use.	*Science at Work: Fibers and Fabrics* p;. 26–32
	j) How do detergents affect a drop of water?	
	k) Different fabrics require different washing instructions; e.g., find the best way to clean dirty cotton fabric. This also illustrates how detergents work.	
	l) Find out more about specialized fabrics, such as a wet suit, fire proof suit, etc.	
	Material used for building homes	*Science at Work, Building Science* pp. 2–7
	• a) Make mortar and test its strength. • b) Make concrete. • c) Make concrete and add materials to it and test it for strength.	
	<u>Ceramics</u>	
	• a) List the properties of ceramics (clay). • b) List the uses of ceramics in industry; e.g., ceramic insulators on an electric transformer.	*Applied Science I*, p. 35–38
	<u>Plastics</u>: Plastic has taken the place of many metals.	*Principles of Science*, pp. 345-347 *Materials & Molecules*, pp. 46–51
	• a) Make plastic from milk. • b) Make a plastic mold. • c) Find out how stress in plastic can be shown by using polarized light.	*Science at Work, Building Science*, pp. 29–32 *Materials & Molecules*, pp. 55–59
	• Read about natural and synthetic polymers; teflon; pvc, etc.	*Technology at Work*, pp. 208–211

CONCEPT 3: The technological process of creating a product can be evaluated.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Describe how products are derived from natural or synthetic sources.	• Discuss the impact of the invention of: a) nylon on the silk stocking industry • Discuss the impact on our lives from the invention of plastic. • Discuss whether we could live without plastic today.	
3.2 Identify products that are in everyday use.	• Identify materials that make up objects we use everyday e.g., kettle, pots and pans, plates.	
3.3 Investigate the industrial process involved in the creation of two products.	• Ask how alloys are made. Brass can be made by combining the metals copper and zinc. • Experiment to find what sorts of fibres make up different types of paper. • Observe the properties of glass. • Experiment with heating glass to make tubes.	*Materials & Molecules*, pp. 14–16 *Science at Work: Fibres and Fabric*, pp. 8–11
3.4 Realize the advantages and disadvantages of the industrial processing of resources to form a product.	• Illustrate the industrial process involved in the manufacture of two products, either by research or by an arranged trip. Ask what disposal techniques are used in the process (any toxic substances). • What types of dyes are used in the dyeing of fabrics? – vegetable dyes – mixtures of dyes	*Science at Work: Fibres and Fabric*, p. 11 *Science at Work: Dyes and Dyeing*, p. 1–5 *Principles of Science*, pp. 347–350

CONCEPT 4: The use of materials has changed many aspects of life.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Describe how non-biodegradable products can cause environmental problems.	• Identify biodegradable substances and non-biodegradable substances by making a collage with cut-out magazine pictures. • Sort out classroom garbage or school cafeteria garbage according to whether it is biodegradable or not.	*Materials & Molecules*, pp. 37-40 *Principles of Science II*, p. 335
4.2 Assess the need for biodegradable products.	• Observe how living organisms (enzymes) are responsible for biodegradation.	*Materials & Molecules*, pp. 41-45
4.3 Describe how products and their applications can change over time as new materials and technologies are developed.	• Plan a field trip to a recycling centre. Learn how solid wastes are separated and recycled. • Look at methods of solid waste disposal. Also look at the by-products of plastics or materials used to manufacture plastics and find out what methods of disposal there are. • What are space suits made of?	*Materials & Molecules*, pp. 28-29
4.4 List the properties of four selected raw materials and identify their contribution to our quality of life.	• Find out the special materials used in the space shuttle (e.g., ceramic tiles). What are some important properties of these materials? • Identify products that would be either non-existent or not as useful without some of the modern materials such as: - plastics (prosthetic limbs) - rubber - nylon, dacron, other synthetic fabrics - fiber optics. • Glass: toughened safety glass for windscreens in automobiles. • Semiconductor: transistor (See Science 14 Unit IV, Understanding Technology. Any extension activities not utilized can be covered in this unit. Teachers may be selective as to the depth covered.) • Superconductor: producing electromagnets, refrigeration systems, superconducting coils. Extension Activity The Science at Work Module Cosmetics, could be used as project option in this unit.	*Technology at Work*, pp. 204-205 *Science at Work Technology Modules & Electronics Module* *Science at Work, Cosmetics*

UNIT IV: SAFE TRANSPORTATION

Overview

Students will study the scientific principles associated with transportation.

The rationale for the technology involved in transportation safety should evolve from this study. An issue related to transportation safety should be thoroughly investigated and the student should develop an informed opinion regarding this issue.

The emphasis of this unit is the nature of science.

SPECIFIC LEARNER EXPECTATIONS

Attitudes

The student will be encouraged to:

1. Appreciate a philosophy of life that reflects personal responsibility.
2. Appreciate that ethical dilemmas may arise from application of technological developments.
3. Appreciate the relationship among science, technology and society in regards to transportation.
4. Accept the need for rules and regulations with respect to transportation safety.

Skills

The student will demonstrate the ability to:

1. Select and apply appropriate problem–solving strategies.
2. Apply data collection, organization, and interpretation skills.
3. Apply deductive reasoning to arrive at a conclusion.
4. Analyse the possible impact of technological development on society.
5. Identify the limits of science and technology.
6. Debate the relationship between consumer's expectations and producer's responsibilities.
7. Implement principles of transportation safety that will contribute to lifelong health and survival.

Concepts

Students will be expected to demonstrate an understanding that:

1. **Collisions involve the conservation of energy.**

   1.1 Relate the momentum of an object to its mass and velocity.
   1.2 Specify that moving objects possess energy of motion called kinetic energy.
   1.3 Relate the energy transferred in a collision to the direction of the moving objects involved.
   1.4 Trace the energy conversions in a collision.

Students will be expected to **demonstrate an understanding that:**

2. **Personal risk involved in the use of technology can be assessed.**

    2.1 Investigate how different modes of travel present different types and degrees of personal risk.
    2.2 Relate the condition and expertise of the vehicle operator to degree of the risk involved.
    2.3 Relate environmental conditions to travel safety.
    2.4 Describe how risk factors may be reduced by use of safety devices and practices.

Students will be expected to demonstrate an understanding that:

3. **Trade-offs are made to arrive at safe, workable situations involving technology in society.**

    3.1 Assess the influences of cost on the development and consumer acceptance of safety devices.
    3.2 Assess the influence of comfort on the design and use of safety devices.
    3.3 Assess how convenience influences safe transport.
    3.4 Consider the issues of vehicle appearance and popularity in relation to vehicle safety.

Students will be expected to demonstrate an understanding that:

4. **Science and technology influence societal issues.**

    4.1 Illustrate with at least one example that technological development occurs in response to the perceived needs and wants of society.
    4.2 Describe how scientific and technological developments provide wider choices for private and industrial activity.

Students will be expected to demonstrate an understanding that:

5. **Safety features are involved in making societal decisions regarding transportation technology.**

    5.1 Identify how vehicle safety is determined by extensive research setting of standards.
    5.2 State the safety standards and licensing requirements for operators of vehicles such as motorcycles, bicycles and cars.
    5.3 State the need for safe transportation corridors.
    5.4 Describe how properly designed and strategically placed road signs and traffic control devices contribute to road safety.

CONCEPT 1: Collisions involve the conservation of energy.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
1.1 Relate the momentum of an object to its mass and velocity.	• Investigate the effects of Newton's first and second laws on automobile passengers. a) Ask what happens to a loose object (driver, passenger, or package) in a moving car if the car stops suddenly. Graph data from the results obtained. b) What happens to a loose object when a car at rest is hit from behind? c) Investigate to see what Newton's second law is and how it applies to a car crash. d) Apply Newton's laws to other similar situations.	*Arrive Alive*, pp. 5–15 *Physics: A Practical Approach*, pp. 102–113
1.2 Specify that moving objects possess energy of motion called kinetic energy.	• Using diagrams, explain how the **law of conservation of energy** applies to car crashes. (Note: in order to understand **conservation of energy**, the concepts of force, weight and mass, friction and work may require explanation. Activities may include these concepts – see references)	*Physics: A Practical Approach*, p. 131
1.3 Relate the energy transferred in a collision to the direction of the moving objects involved.	• **Momentum** is the product of the mass of an object and its speed. Identify examples of objects with varying degrees of momentum. • Apply the law of conservation of momentum to simulated automobile collisions. • Find the average speeds of 1) a Concorde, 2) a Boeing 747, 3) a cheetah, 4) a human running, 5) a space shuttle.	*Arrive Alive*, p. 40
1.4 Trace the energy conversion in a collision.	• Calculate the acceleration forces on cars & passengers during collisions, using Newton's second law of motion.	*Arrive Alive*, p. 13–15

CONCEPT 2: Personal risk involved in the use of technology can be assessed.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
2.1 Investigate how different modes of travel present different types and degrees of personal risk.	• Obtain statistics on car accidents versus total number of cars. Compare these statistics with those of planes, boats, and so on.	
2.2 Relate the condition and expertise of the vehicle operator to the degree of risk involved.	• Career training for pilot, railway engineer, auto transportation. • Drinking and driving. • Eyesight.	*Arrive Alive*, pp. 47–55
2.3 Relate environmental conditions to travel safety.	• Driving in winter. • Hydroplaning. • Front wheel versus rear wheel drive on slippery roads.	
2.4 Describe how risk factors may be reduced by use of safety devices and practices.	• Make and test a padded dashboard, a safety belt system, and an air bag system to see how to protect passengers in auto crashes. a) What is the major advantage of a padded dash over an unpadded one? b) Which belt (string, shoelace, or elastic) gives the best protection to a passenger? – What is the major advantage of a seat belt—shoulder harness system over a seat belt system? – Investigate the properties of a car seat belt and also any other mechanisms involved in seat belt function. – How do airbag systems protect passengers from injuries during accidents? • Safety design is related to the change in momentum after a collision. a) Design a car: – illustrate it, pointing to safety features – describe how the passenger is protected. b) Make an advertisement to "sell" your latest car design. • What are common arguments for restraining children while travelling in vehicles?	*Arrive Alive*, pp. 18, 22, 26–31 *Arrive Alive*, p. 23

CONCEPT 3: Trade-offs are made to arrive at safe, workable situations involving technology in society.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
3.1 Assess the influences of cost on development and consumer acceptance of safety devices.	• Visit an auto dealership and see the three types of restraining systems described.	
3.2 Assess the influence of comfort on the design and use of safety devices.	• Use of airbags for shock absorption. • Safety helmets.	*Arrive Alive*, pp. 23–25
3.3 Consider how convenience influences safe transport.	• Mobility in the vehicle/aircraft. • Discuss the use of safety helmets.	
3.4 Consider the issues of vehicle appearance and popularity in relation to vehicle safety.	• List various modes of transportation. a) Identify the safety features used. b) Identify the safety features used on the road.	*Arrive Alive*, pp. 56–67

CONCEPT 4: Science and technology influence societal issues.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
4.1 Illustrate, with at least one example, that technological development occurs in response to the perceived needs and wants of society.	• Devise a method of packaging an egg in order for it to survive a six metre drop. • Report on design of packaging and materials used (diagram or photograph the product). • Invite a local police officer to talk about seat belt safety, the required regulations, and the penalties involved. • Invite a speaker from the motor vehicles and licensing bureau. • Invite an insurance agent to speak on the statistics of accidents involving the use of seat belts and accidents in which seat belts were not worn, and the claims allowed.	*Arrive Alive*, p. 16–17
4.2 Describe how scientific and technological developments provide wider choices for private and industrial activity.		

CONCEPT 5: Safety features are involved in making societal decisions regarding transportation technology.

SUB-CONCEPTS	SAMPLE ACTIVITIES	REFERENCES
5.1 Vehicle safety is determined by extensive research and standard setting.	• Set up a classroom debate for the pros and cons of a law requiring the wearing of lap/shoulder seat belts. • Survey the student population as to their choice.	*Arrive Alive*, pp. 26–31
5.2 State the safety standards and licensing requirements for operators of vehicles such as motorcycles, bicycles and cars.	• Invite a motor vehicles branch person to demonstrate the apparatus known as the "convincer." • Discuss the Operator's Manual for driving licences. • Why do you think the new technological developments led to an increase in serious traffic accidents?	*Arrive Alive*, pp. 56–62
5.3 State the need for safe transportation corridors.		
5.4 Describe how properly designed and strategically placed road signs and traffic control devices contribute to road safety.		*Arrive Alive*, pp. 63–67

SCIENCE 14/24 OPTIONAL UNITS

Suggested Optional Unit: Nutrition

Overview

The students will obtain the latest information on nutrition which will provide students with background necessary for considering the alternatives prior to making decisions concerning their personal health or the health of others in our society.

The emphasis of this unit is science, technology and society.

Attitudes

Students will be encouraged to

- appreciate the relationship between diet and lifestyle
- develop a responsible attitude toward tobacco, alcohol, and drugs
- develop a philosophy reflecting responsibility to self and others
- appreciate the ethical dilemmas that may arise from the application of scientific research and/or technological developments.

Skills

Students will be expected to demonstrate an ability to

- devise a personal strategy for maintaining a healthy body, emphasizing prevention of potential problems
- examine evidence and consider alternatives before making a decision
- examine and assess a variety of viewpoints on controversial issues before forming an opinion
- relate individual needs to societal concerns
- recognize the technological advancements in health care related to nutrition
- classify foods into groups as outlined by the Canada Food Guide
- perform specific laboratory tests to identify proteins, fats, and carbohydrates in foods
- collect and analyze personal food intake data
- interpret the terminology found on food labels
- use labels on prepackaged foods to classify the ingredients into nutrient or non-nutrient categories.

Concepts

1. *Students will be expected to* demonstrate an understanding that daily food intake should include minimal amounts of certain foods in order to maintain health.

   1.1 Define *nutrient*.
   1.2 Review the Canada Food Guide definition of good nutrition.
   1.3 Define and give examples of *carbohydrates*, *fats*, and *proteins*.
   1.4 Identify the major functions of carbohydrates, fats, and proteins in the human body.
   1.5 Deduce that many foods are combinations of carbohydrates, fats, and proteins.
   1.6 Explain why a healthy diet consists of a balance of foods from each group.
   1.7 Explain the general role of vitamins and minerals in the body and identify common sources of these nutrients.
   1.8 Describe Canada's food-labelling laws and how they assist the consumer in selecting foods with appropriate nutrients.

2. *Students will be expected to* demonstrate an understanding that much of our food, particularly processed food items, contain additives.

   2.1 Define *additive*.
   2.2 List common food additives found in or on foods.
   2.3 Identify the function of these additives.
   2.4 Outline Canada's labelling laws regarding additive listing.
   2.5 Discuss the benefits of labelling laws to the consumer.

3. *Students will be expected to* demonstrate an understanding that alcohol, drugs, and tobacco can relate to nutrition.

   3.1 Define *alcohol* and *drugs*.
   3.2 Analyze the effect of alcohol, drugs, and tobacco on an individual's appetite and nutritional needs.
   3.3 Describe a specific disease related to each of alcohol, drug, and tobacco abuse.
   3.4 Relate these diseases to the effects on nutrition.

4. *Students will be expected to* demonstrate an understanding that the consequences of improper diet can range from minor deficiencies to life-threatening conditions.

   4.1 Specify how a lack of vitamins or minerals may lead to deficiency diseases.
   4.2 Describe how fad diets and packaged meal supplements may lack essential food groups, minerals, and vitamins and may be hazardous to one's health.
   4.3 Define/describe *anorexia* and *bulimia*.
   4.4 State why anorexia and bulimia are life threatening.
   4.5 Cite at least one example of technological advancement in health care related to nutrition.
   4.6 Analyze diet and activity level based on energy requirements and suggest improvements.
   4.7 Deduce that reducing diets are most effective when a major lifestyle change is implemented and a lasting balance of food intake and activity results.

Suggested Optional Unit: Geology

Overview

Several theories have been used to explain the existence of geological forces such as volcanoes and earthquakes. Students will examine evidence and determine how well the current theory and model explain such evidence. Activities should promote the students' understanding of the important role technologies, such as remote sensing and Richter scale determinations, play in the collection of relevant data.

The emphasis of this unit is the nature of science.

Attitudes

Students will be encouraged to

- recognize that scientific knowledge is cumulative and subject to change
- appreciate the limits of science and technology in problem solving
- appreciate the ethical dilemmas that may arise from the application of scientific research and/or technological developments
- appreciate that proposed theories such as "plate tectonics" may be supported or refuted by experimental results
- appreciate the relationship between science and technology in the area of geology
- appreciate the beauty/magnitude of the earth's geological features and processes.

Skills

Students will be expected to demonstrate an ability to

- apply data collection, organization, and interpretation skills
- identify trends in data and make predictions from those trends
- use established scientific models as a comparative base for observable data
- identify components and interactions within geological systems
- use precise terminology and symbols.

Concepts

1. *Students will be expected to* demonstrate an understanding that movements of the earth's crust result in earthquakes, volcanoes, and mountain building.

   1.1 Describe theories that explain dynamic changes occurring in the earth's crust.
   1.2 Illustrate using at least one example that movement of the earth's crust is localized.
   1.3 Identify the current theory explaining the earth's internal structure.
   1.4 Assess evidence on the current theory of the internal structure of the earth.

2. *Students will be expected to* demonstrate an understanding that the forces of nature can be explained by the movement of water, air, and land.

   2.1 Assess why movement requires an energy source.
   2.2 Describe how forces cause specific patterns of movement of water, air, and land.
   2.3 Investigate and describe how movement of water, air, and land can alter the surface of the earth.

3. *Students will be expected to* demonstrate an understanding that technology can be used to predict the forces of nature.

   3.1 Assess the limitations of modern technology in measuring and accurately predicting the earth's movement using one example.
   3.2 Explain why the earth's movement can be measured, but not accurately predicted, even with modern technology.
   3.3 Describe how the technology involved in predicting the forces of nature is developing rapidly.
   3.4 Examine and describe a rapidly developing technology associated with predictions of the forces of nature.

4. *Students will be expected to* demonstrate an understanding that theories may be updated based on new evidence.

   4.1 Describe the historical development of a current theory that offers a explanation for a geological feature and/or process.
   4.2 Explain how the accumulation of data contributes to evidence that may support, modify, or refute a theory explaining a geological feature and/or process.

Suggested Optional Unit: Weather

Overview

Present-day theories and models of the earth's atmosphere attempt to explain weather phenomena such as hurricanes, tornadoes, violent storms, and general weather patterns. Students will examine the evidence and determine how well the theory and model explain such evidence. The contribution of technological data-gathering techniques and devices such as weather satellites will be considered.

The emphasis of this unit is the nature of science.

Attitudes

Students will be encouraged to

- recognize that scientific knowledge is cumulative and subject to change
- identify the limits of science and technology in problem solving
- appreciate the ethical dilemmas that may arise from the application of scientific research and/or technological developments
- appreciate that proposed theories attempting to explain weather phenomena may be supported or refuted by experimental results
- appreciate the relationship between science and technology as related to the explanation and prediction of weather phenomena
- appreciate the power and magnitude of weather phenomena.

Skills

Students will be expected to demonstrate an ability to

- apply data collection, organization, and interpretation skills
- identify trends in data and make predictions from those trends
- use established scientific models as a comparative base for observable data
- use precise terminology and symbols.

Concepts

1. *Students will be expected to* demonstrate an understanding that the earth's atmosphere can be monitored for temperature, pressure, and speed.

   1.1 Relate weather patterns to the constant flux of the earth's atmosphere.
   1.2 Identify and use technology associated with measuring various characteristics of air masses.
   1.3 Investigate various weather patterns and their impact on the earth's surface.

2. *Students will be expected to* demonstrate an understanding that weather can be explained by the movement of water and air.

   2.1 Describe why movement requires an energy source.
   2.2 Identify and describe the energy sources and energy conversions involved in such movements.
   2.3 Describe how forces cause specific patterns of movement of air and water.

3. *Students will be expected to* demonstrate an understanding that technology can be used to predict the forces of nature.

   3.1 Describe how weather can be predicted and discuss why forecasts are accurate and inaccurate.
   3.2 Describe how technology plays a key role in weather forecasting.
   3.3 Describe how the technology involved in predicting the weather is developing rapidly.
   3.4 Identify and describe a rapidly developing technology associated with prediction of weather.

4. *Students will be expected to* demonstrate an understanding that theories may be updated based on new data.

   4.1 Describe the historical development of a present-day theory that offers explanation of a weather related force of nature (e.g., tornado formation).
   4.2 Explain how the accumulation of data may support, or refute, a theory that explains a weather phenomenon.

LEARNING RESOURCES

STUDENT RESOURCES

Basic learning resources are those resources approved by Alberta Education as the most appropriate for meeting the majority of goals and objectives of the course, or substantial components of the course outlined in the provincial program of studies.

Recommended learning resources are those resources approved by Alberta Education because they complement basic resources by making an important contribution to the attainment of one or more of the major goals of courses outlined in the provincial programs of studies.

Supplementary learning resources are those resources approved by Alberta Education because they support courses outlined in the provincial programs of studies by enriching or reinforcing the learning experience.

The ISIS modules revised by Glen Hutton and published by Globe/Modern Curriculum Press have been authorized as the basic learning resource for Science 14/24. A number of additional print and video resources have been authorized for recommended and supplementary status. Because of the modular format of much of the materials, the listing of student resources is listed here separately for each unit.

The basic resource modules are available through the Learning Resources Distributing Centre (LRDC). A buyers guide is available from the LRDC at the following address:

Learning Resources Distributing Centre
12360 - 142 Street
Edmonton, Alberta
T5L 4X9
Phone: (403) 427-2767

Recommended and supplementary print resources are available from the publishers. The video resources listed are available for purchase through ACCESS as well as on loan through the regional resource centres and urban media centres.

Science 14 Unit I: Body Systems

Basic Resource:
Your Body in Balance. Scarborough: Globe/Modern Curriculum Press, 1989.

Recommended Resources:
Video - *The Human Body Series.* Mississauga. National Geographic, 1988
The series contains the following titles:
Muscular and Skeletal Systems, Digestive System, Circulatory and Respiratory Systems, Nervous Systems, Reproductive Systems.

Supplementary Resources:
Principles of Science, Book Two (Unit 1). Columbus, Ohio: Merrill, 1979.
Body Maintenance. Harlow, England : Longman UK, 1985.

Science 14 Unit II: Household Science

Basic Resource:
Household Science. Scarborough. Globe/Modern Curriculum Press, 1989.

Recommended Resource:
Video – *Acme School of Stuff (Prog. 1).* Toronto: TV Ontario, 1988.

Supplementary Resources:
Principles of Science, Book Two (Ch. 16 & 17). Columbus, Ohio: Merrill, 1979
Food and Microbes. Harlow Longman,England: Longman UK, 1985.
Video – *Household Hazardous Waste Management,* Edmonton; Abraxas, 1988.

Science 14 Unit III: Investigating the Environment

Basic Resource:
Investigating the Environment. Scarborough: Globe/Modern Curriculum Press, 1989.

Recommended Resources:
Video – *Acme School of Stuff (Prog. 2).* Toronto: TVOntario, 1988.

Supplementary Resources:
Pollution, Harlow, England: Longman UK, 1985.

Science 14 Unit IV: Understanding the Technology

Basic Resource:
Science, Technology and You. Scarborough. Globe/Modern Curriculum Press, 1989.

Recommended Resources:
Video – *Acme School of Stuff Series (Prog. 1–13).* Toronto: TV Ontario, 1988.

Supplementary Resources:
Principles of Science, Book Two (Ch. 19 & 20) Columbus, Ohio: Merrill, 1979.
Photography Harlow, England: Longman UK, 1985.
Electronics Harlow, England: Longman UK, 1985.
Gears and Gearing Harlow, England: Longman UK, 1985.
Domestic Electricity Harlow, England: Longman UK, 1985.

Science 24 Unit I: Disease Defense

Basic Resource:
Disease Defense Scarborough: Globe/Modern Curriculum Press, 1989.

Recommended Resources:
Video – *Our Immune System.* Mississauga: Ontario, National Geographic,1988.

Supplementary Resources:
Principles of Science, Book Two (Ch. 8). Columbus, Ohio: Merrill, 1979.
Video – *Viruses: What They Are and How They Work.* Bert Ban Book, 1988.

Science 24 Unit II: Energy Consumption

Basic Resource:
Energy for Living. Scarborough: Globe/Modern Curriculum Press, 1989.

Recommended Resources:
Video – *Acme School of Stuff (Prog. 6)*. Toronto: TVOntario, 1988.

Supplementary Resources:
Energy. Harlow, England: Longman UK, 1985.

Science 24 Unit III: Materials We Use

Basic Resource:
Materials and Molecules. Scarborough: Globe/Modern Curriculum Press, 1989.

Recommended Resources:
Video – *Acme School of Stuff (Prog. 6, 10, 12)*. Toronto: TVOntario, 1988.

Supplementary Resources:
Building Science, harlow, England: Longman UK, 1985.

Science 24 Unit IV: Safe Transportation

Basic Resource:
Arrive Alive. Scarborough: Globe/Modern Curriculum Press, 1989.

Recommended Resources:
Video – *Acme School of Stuff* (Prog. 5, 6, 11, 12). Toronto: TV Ontario, 1988.

Supplementary Resources:
Alive!: Adolescents and Alcohol and Driving, AADAC, 1987.
Alberta Traffic Collision Statistics, 1987, Alberta Transporation Services, 1988.

Science 14/24 Elective Units

Basic Resource:
Food Power. Scarborough: Globe/Modern Curriculum Press, 1989.
Everybody Talks About the Weather. Scarborough: Globe/Modern Curriculum Press, 1989.
Earth Changers. Scarborough: Globe/Modern Curriculum Press, 1989.

Supplementary Resources:
Science at Work Series. Harlow, England: Longman UK, 1985.
The series contains the following modules:
Body Maintenance, Building Science, Cosmetics, Energy, Domestic Electricity, Dyes and Dyeing, Earth Science, Electronics, Fibres and Fabrics, Flight, Food and Microbes, Forensic Science, Gears and Gearing, Photography, Plant Science, Pollution, Science of the Motor Car, You and Your Mind.

Science at Work: Technology Series. Harlow, England: Longman UK, 1985.
The series contains the following modules:
Biotechnology, Computers and Computing, Electronics in Control, Microcomputers in Control, Microelectronics in Control, Telecommunications.

The Acme School of Stuff series is listed as a recommended resource because it is very suitable to the science and technology emphasis in the Science 14/24 program.

This 13-part series, produced by TV Ontario, explores the science and technology involved in everyday items like cassette tapes and microwave ovens. Host David Stringer uses a variety of household objects and homemade gadgets to help with his explanations of modern technology. With one exception, each program contains three items, two with David Stringer in his work area, and one a documentary on location.

PROGRAMS IN THE ACME SCHOOL SERIES

Program 1
BPN 319001
Topics: cassette tapes, chocolate, and microwave ovens.

Program 2
BPN 319002
Topics: telephones, sewage treatment and video.

Program 3
BPN 319003
Topics: batteries, water and fuel injection.

Program 4
BPN 319004
Topics: records, neon and the cathode-ray tube.

Program 5
BPN 319005
Topics: light bulbs, the Canadian Standards Association and modems.

Program 11
BPN 319011
Topics: electronics, the body shop and coin units in vending machines.

Program 12
BPN 319012
Topics: composite substances, piano rolls and automobile alignment.

Program 6
BPN 319006
Topics: electricity, glass bottles and brakes.

Program 7
BPN 319007
Topics: the history, operation, manufacturing, and testing of the toilet.

Program 8
BPN 319008
Topics: cable television, the subway and engineering.

Program 9
BPN 319009
Topics: traffic signals, a natural gas pipeline and alternating current.

Program 10
BPN 319010
Topics: digital computers, folding paper cartons and the electric shaver.

Program 13
BPN 319013
Topics: engines, wire and satellites.

TEACHER RESOURCES

TEACHING ACTIVITIES

Andrews, William A. *Biological Science: An Introductory Study.* Scarborough: Prentice-Hall of Canada, 1980.

Asimov, Isaac. *Great Ideas of Science.* Boston: Houghton Mifflin Company, 1969.

Asimov, Isaac. *Asimov's Guide to Science.* New York: Basic Books Inc., 1972.

Bisacre et al (Editors). *The Illustrated Encyclopedia of Technology.* London: Marshall Cavendish Books Limited, 1984.

Buban, P., Schmidt, M.L., and Carter, C.G. *Understanding Electricity and Electronics Technology.* New York: McGraw-Hill, 1987.

Cooke, Jean. *Man-Made Wonders of the World.* London: Octopus Books Ltd., 1980.

Concepts and Challenges in Physical Science, Book 2. CEBCO Standard Publications, 1975.

Crump, Donal J. (ed). *On the Brink of Tomorrow: Frontiers of Science.* Washington: National Geographic Society (Special Publications Series 17 #3), 1982.

Durie, Bruce. *Visual Science (series).* London: MacDonald Educational, 1987.

Feldman, Anthony. *Technology at Work.* London: Aldus Books Ltd., 1980.

Getchell, B., et al. *Health.* (Teacher's Edition) Boston: Houghton Mifflin, 1987.

Goetsch, David L. and Nelson, John A. *Technology and You.* New York: Albany, Delmar Publishers Inc., 1987.

Goldstein, Martin. and Goldstein, Inge. *The Experience of Science: An Introductory Approach.* New York: Plenum Press,1986.

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Hirsch, Alan J. *Physics: A Practical Approach.* Toronto: John Wiley & Sons, 1981.

How it Works: The New Illustrated Encyclopedia of Science and Technology. New York: Marshall Cavendish, 1978.

Jaret, Peter. "Our Immune System: The Wars Within". *National Geographic,* June, 1986. Volume 169, no. 6.

Jenkins, F. et al. *Solar Energy.* Edmonton: J.M. LeBel Enterprises Ltd.,1980.

Kaskel, Albert et al. *Laboratory Biology: Investigating Living Systems.* (Teacher's annoteted edition) Merrill, 1983.

Liem, Tik L. *Invitations to Science Inquiry.* Lexington, Massachusetts: Ginn Custom Publishing,, 1982.

Moyer, R.H. and Bishop, J.E. *General Science.* Columbus, Ohio: Merrill, 1986.

Ritter, Robert et al. *Biology: A Canadian Laboratory Manual.* Agincourt, Ont: Silver Burdett, 1987.

Silverstein, Alvin and Silverstein,Virginia. *Future Life: The Biotechnology Revolution.*Englewood Cliffs, NJ: Prentice Hall, 1982.

The Smithsonian Book of Invention. Washington: Smithsonian Books (Distributed by W.W. Norton &Company), New York, 1978.

Sochurek, Howard. *Medicine's New Vision.* National Geographic, January, 1987.

Wilde, George. *Applied Science, Book I.* Longman Cheshire, 1986.

Wray et al. *Energy Technologies Teacher's Resource Book.* SEEDS Energy Literacy Series, Science Research Associates (Canada) Limited, Toronto, 1983.

Safety in the Classroom

Armour, Margaret-Ann; Browne, Lois M., Weir, Gordon L. *Hazardous Chemicals: Information and Disposal*, Edmonton, University of Alberta, 1985.

Science Education Consultants. *Safety and Organization in School Science Facilities (Second Edition)*, Edmonton, Alberta Education, 1985.

STS Background

Aikenhead, Glen S. *Science in Social Issues: Implications for Teaching.* Ottawa: Supply and Services Canada, 1980.

Association for Science Education. *Nature of Science: Reader J.* London: Heinmann Education Books, 1981.

Braun, E., Collingridge, D., and Hinton, K. *Decisions on Technology.* The SISCON (Science in a Social Context) Project, Leeds, 1976.

Bronowski, J. *The Ascent of Man.* Boston: Little Brown, 1973.

Burke, J. *Connections.* London: Macmillan, 1978.

Burke, J. *The Day the Universe Changed.* London: BBC, 1985.

Gardiner, Martin. *Science: Good, Bad, and Bogus.* Buffalo: Prometheus Books, 1981.

George, D.A. *An Engineer's View of Science Education.* Ottawa: Supplies and Services Canada, 1981.

Holton, Gerald. *The Scientific Imagination: Case Studies.* New York: Cambridge University Press 1979.

Kuhn, Thomas S. *The Structure of Scientific Revolutions.* Chicago: The University of Chicago Press, 1970.

Lispcombe, J. and Williams, B. *Are Science and Technology Neutral?* The SISCON (Science in a Social Context) Project, Leeds, 1977.

MacDonald, S., Collingridge, D., and Braun, E. *From Science to Technology: The Case of Semiconductors.* The SISCON (Science in a Social Context) Project, Leeds, 1975.

Munby, Hugh. *What is Scientific Thinking?* Ottawa: Supplies and Services Canada, 1982.

Pavitt, K., and Worboys, K. *Science, Technology and the Modern Industrial State.* The SISCON (Science in a Social Context) Project, Leeds, 1977.

Resource Documents

Clarification of Statements Prohibiting the Use of Human Body Substances in the Alberta Science Curriculum. Edmonton, Alberta Education, 1988.

Essential Concepts, Skills and Attitudes for Grade 12. Edmonton, AlbertaEducation, 1987.

Focus on Research: A Guide to Integrated Research Procedures for Alberta School Libraries. Edmonton, Alberta Education, In Press.

Gage Canadian Dictionary. Toronto: Gage Publishers, 1983.

How to Evaluate Progress in Problem Solving. Peston, Virginia: National Council ofTeachers of Mathematics, 1987.

Language Across the Curriculum: Guidelines for Schools. London: Ward Lock Educational in association with the national Association for the Teaching of English, 1976.

Learning Contexts for Junior High Science. Edmonton, Alberta Education, InPress, 1989.

Making the Grade: Evaluating Student Progress. Scarborough, Ontario: Prentice Hall, 1987.

Roots in the Sawdust: Writing to Learn Across the Disciplines. Edited by Ann Ruggles Gere. Urbana, Illinois: National Council of Teachers of English (NCTE), 1985.

STS Science Education: An Opportunity for Unifying the Goals of Science Education. Edmonton, Alberta Education, In Press, 1989.

Students' Interactions: Developmental Framework, the Social Sphere. Edmonton, Alberta Education, 1988.

Students' Physical Growth: Developmental Framework Physical Dimension. Edmonton, Alberta Education, 1988.

Students' Thinking: Developmental Framework Cognitive Domain. Edmonton, Alberta Education, 1987.

Teaching Thinking: Enhancing Learning. Edmonton, Alberta Education, InPress, 1989.

Teaching Thinking: An Alberta Education Position Statement. Edmonton, Alberta Education, In Press, 1989.

GOVERNMENT AGENCIES

The following government agencies are will to provide various types of information supporting the goals and objectives of the Science 14/24 Program.

Alberta Alcohol and Drug Abuse Commission (AADAC)
8th Floor, Energy Square Building
10109 - 106 Street
Edmonton, Alberta
T5J 3L7

(403) 427-4267

AADAC District Offices:

Northwest District Office
Provincial Building, Room 2204
10320 – 99 Street
Grande Prairie, Alberta
T8V 6J4

(403) 538–5214

Northeast District Office
Provincial Building
9503 Beaver Hill Road
Lac La Biche, Alberta
T0A 2C0

(403) 623–5287

Central District Office
Main Floor, Provincial Building
4920 – 51 Street
Red Deer, Alberta
T4N 6K8

(403) 340–7165

Southern District Office
Third Floor, 1177 – 11 Avenue, S.W.
Calgary, Alberta
T2R 0G5

(403) 297–3038

Alberta Economic, Development & Trade
6th Floor, Sterling Place
9940 –106 Street
Edmonton, Alberta
T5K 2P6

(403) 427-0670

Alberta Energy
Energy Conservation Branch
2nd Floor, Highfield Place
10010 – 106 Street
Edmonton, Alberta
T5J 3L8

(403) 427–5200
FAX (403) 423–1474

Alberta Technology, Research &
Telecommunications
12th Floor, Pacific Plaza
10909 Jasper Avenue
Edmonton, Alberta
T5K 2J6

(403) 422–0567
FAX (403) 420–1474

Alberta Transportation & Utilities
Motor Transport Services
Twin Atria Building
1999 – 98 Avenue
Edmonton, Alberta
T6B 2X3

(403) 427–7674

Environment Council of Alberta
8th Floor, Weber Centre
5555 Calgary Trail Southbound N.W.
Edmonton, Alberta
T6H 5P9

(403) 427–5792

MEDIA AND TECHNOLOGY

There is a growing collection of media resources that support the goals of the Science 14/24 program. As with any resource, films and videos should be selected with due consideration for the goals of the program and the needs of your class.

GUIDELINES FOR EFFECTIVE MEDIA INTEGRATION

Here are some questions to consider when selecting media resources for use in the classroom.

- Does it support the major goals and objectives of the program?
- Does it meet individual student needs and learning styles?
- Does it reinforce, enrich, or extend the program?
- How appropriate is the timing?
- Does the media demonstrate abstract ideas?
- How well does the media fit into existing curricula and teaching/learning needs?
- How clear are the educational aims and objectives?
- What kind of preparation is required?
- How is teaching learning evaluated?
- What forms of follow-up are required?

ACCESS NETWORK

The ACCESS Audio/Visual Catalogue lists numerous resources that are appropriate for the Science 14/24 Program. All of the programs listed in the Audio/Visual Catalogue have been produced or acquired by ACCESS and are available on video or audio tape for use in Alberta schools. ACCESS does not loan out its programs, but provides a provincial dubbing service. For further information on ACCESS materials call 1-800-352-8293 outside of Calgary, and 256-1100 in Calgary, or write to the following address:

ACCESS NETWORK
Media Resource Centre
295 Midpark Way S.E.
Calgary, Alberta
T2X 2A8

RESOURCE/MEDIA CENTRES

There are 12 resource/media centres in Alberta that carry films and videos that support the Science 14/24 program. Each centre publishes its own catalogue, listing the resources in its collection. These centres operate as libraries, lending out audiovisual materials for specified time periods. For more information teachers should contact their local resource/media centre. See the attached list.

REGIONAL RESOURCE CENTRES

Zone 1

Zone One Regional Film Centre
P.O. Box 6536
10020 – 101 Street
Peace River, Alberta
T8S 1S3
Telephone: (403) 624-3187

Zone 2/3

Central Alberta Media Services (CAMS)
2017 Brentwood Boulevard
Sherwood Park, Alberta
T8A 0X2
Telephone: (403) 464-5540
467-8896

Zone 4

Alberta Central Regional Educational Services (ACRES)
County of Lacombe
Box 3220
5140 – 49 Street
Lacombe, Alberta
T0C 1S0
Telephone: (403) 782-5730

Zone 5

South Central Alberta Film Federation (SCAFF)
Westmount School
Box 90
Wheatland Trail
Strathmore, Alberta
T0J 3H0
Telephone: (403) 934-5028

Zone 6

Southern Alberta Regional Film Centre (SAFRC)
McNally School
P.O. Box 845
Lethbridge, Alberta
T1J 3Z8
Telephone: (403) 320-7807

URBAN MEDIA CENTRES

County of Strathcona
Learning Resource Service
2001 Sherwood Drive
Sherwood Park, Alberta
T8A 3W7
Telephone: (403) 464–8235

Calgary Separate School Board
Instructional Materials
6220 Lakeview Drive S.W.
Calgary, Alberta
T3E 6T1
Telephone: (403) 246–6663

Edmonton Public School Board
Learning Resources Centre
Centre for Education
One Kingsway
Edmonton, Alberta
T5H 3G9
Telephone: (403) 429–8320

Edmonton Catholic Schools
Curricular Resources
St. Anthony's Teacher Centre
10425 – 84 Avenue
Edmonton, Alberta
T6E 2H3
Telephone: (403) 439–7356

Red Deer Public School Board
4747 – 53 Street
Red Deer, Alberta
T4N 2E6

Telephone: (403) 343–1405

Calgary Board of Education
Education Media
3610 – 9th Street S.E.
Calgary, Alberta
T2G 3C5
Telephone: (403) 294–8540

Medicine Hat School District
Instructional Materials Centre
601 First Avenue S.W.
Medicine Hat, Alberta
T1A 4Y7

Telephone: (403) 526–1323

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Roberts, Douglas. (1982). Developing the concept of "curriculum emphases" in science education. *Science Education*, 66(2), 243–260.

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DATE DUE SLIP
